Part L, SBEM & What you need to know to get your building to pass.

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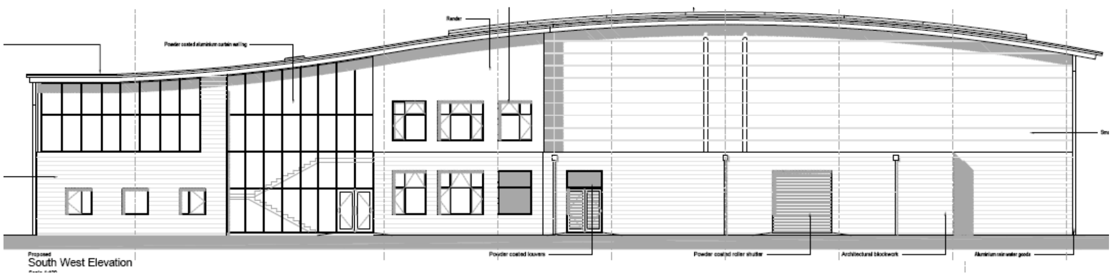


The Building Regulations Part L2A, SBEM & the National Calculation Methodology – what they are, how they affect your building design, and what you need to know.

"If at first the idea is not absurd, then there is no hope for it" - Albert Einstein

Introduction

I like the quote above because when I first thought about trying to write this book, and the accompanying volumes too, I thought it was slightly bonkers to try and summarise the whole process, and also I didn't want to just repeat what was written in the manuals. It also became clear to me that many people get confused by what they are being asked to provide in order to comply with the Part L, and also that as an assessor, we have requirements for information that will help both the client and ourselves to complete the calculation in the most time and cost effective way and still achieve the best results for the building – a lot of this is down to the quality of the information supplied. This book will hopefully make the whole process of what is required, and the information needed to carry out the calculations, a lot easier to understand, and also provide a little bit of information about why the calculation gives the result it does.

Do any of these sound familiar to you?

- If you are an architect and you are asked by Building Control to provide an SBEM calculation, do you know what they mean?
- If you are a Building Control officer do you know what is actually required when you ask for an SBEM calculation to demonstrate compliance?
- Do you know what buildings actually require an SBEM calculation?
- Do you know what energy assessors actually do, and what information they need to carry out the calculations?
- What is an SBEM calculation and why do I need one?

If you answered "No" or 'Don't know" to any of the questions above you are not alone, and the purpose of this book is to answer those questions and many more you may have too.

In fact the aim of this book is simple, to explain the main requirements of Part L2A, how this links in with the compliance National Calculation Methodology, the NCM, how the NCM informs SBEM, the tool used to demonstrate compliance for L2A, and what information the building designer will need to supply to an approved assessor in order to carry out the SBEM calculation.
Finally, and perhaps most importantly for you if you are the building designer, it will cover what impacts the design the most in terms of gaining a pass.
Its not a step by step on how to pass the regulations, I am not an architect or building designer, so whilst suggestions made will gain compliance, they would also need to be checked for their feasibility in actual construction terms and also how one aspect of the design will influence one or more others. That said, the suggestions made are realistic, they just may not be applicable to all building types.

On a final note, writing this type of document whilst interesting, could as easily be as dull as ditchwater, so baring that in mind I have tried to make it an easy read, and I make no apologies for my sense of humour!

Also included with the book is an SBEM input excel spreadsheet which is designed for clients to be able to provide the detailed information an assessor will need, in a format that is applicable to the input fields in iSBEM.

Who or what is an Approved Assessor?

Assessors have to complete a training course using their chosen iSBEM modelling tool, pass an exam, submit a number of properties for assessment, and once passed can practice as an approved assessor. They must also belong to an Approved Accreditation Scheme and follow each scheme Code of Conduct, have appropriate insurance, and carry out a prescribed number of hours of Continuing Personal Development each year.

There are 3 levels of competence for Non Domestic Energy Assessors (NDEA) – Level 3 assessors can only produce Energy Performance Certificate's (EPC's) for existing buildings that have low temperature hot water boilers and/or air conditioning below 12kW. Therefore a level 3 assessors cannot provide an SBEM calculation for any Part L compliance.
Level 4 assessors can produce Part L compliance checks and EPC's on both existing and new buildings, which include both low, medium and high temperature boilers as well as nearly all types of air conditioning. In fact level 4 assessors can provide both the Part L checks and EPC on nearly all buildings with the following exceptions - buildings with Ventilation with enhanced thermal cooling to the structure, automatic blind controls and those with atria. A Level 5 assessor must produce these reports, usually by utilising some Dynamic Simulation Modelling and not SBEM.

Who am I?

I have been producing calculations and reports for all aspects of Part L for a number of years, and work with Architects and Building Control bodies providing guidance and training in all aspects of Part L, and also work with them to help clients gain compliance. It's important to me that the result is the best that is achievable, and not just a pass to gain compliance minimums, if you are going to do the job you may as well do it to the best possible standard.

I am qualified to produce SBEM calculations and EPC's as a level 4 Non Domestic Energy Assessor. I have worked on hundreds of buildings of all types, from small two room warehouses and retail shops to very large office buildings and factories. I am a Public Building Assessor able to produce Display Energy Certificates (DEC's), and a qualified SAP assessor for domestic work for compliance with L1A. I also am qualified to provide calculations for existing buildings for compliance with Part L1B and L2B and I am a Code for Sustainable Homes Assessor.

This book is the first of a four part series covering all four sections of Part L compliance, namely – Part L1A new domestic buildings, Part L1B, existing domestic buildings, Part L2A new build non domestic buildings, and Part L2B existing non domestic buildings

What is Part L2A?

Part L2A is one part of the four parts to Part L of the Building Regulations – Conservation of Fuel and Power in new buildings other than dwellings.
This book concerns the requirements of the October 2010 Regulations, and will be updated as the Regulations are changed, the next due at time of writing in 2013.

The Regulations and how to comply with them are contained in an Approved Document, ADL2A, there are other ways of demonstrating compliance with the Regulations but in terms of the most straightforward, following the guidance in the AD is the simplest.

In fact there are only two Regulations for Part L - 17C and 17E of the main Building Regulations, which are these:
17C - Where a building is erected, it shall not exceed the target CO2 emission rate for the building that has been approved pursuant to regulation 17B.

17E – Energy Performance Certificates – to what buildings do they apply, who shall provide them, when they must be produced, and what they must contain.
So by carrying out an SBEM calculation and the eventual EPC, both those Regulations are complied with, easy!
There are also the specific requirements of Part L – Reasonable provision shall be made for the Conservation of Fuel and Power in buildings by:
"Limiting heat losses and gains, providing fixed building services which are energy efficient, have effective controls that are commissioned and tested, provide the owner with sufficient information about the building and the fixed services so that the building can be operated to use no more fuel and power than is reasonable".

All the above Regulations are covered when completing an SBEM calculation and EPC for a new building, guidance on how to do so is covered in ADL2A.

So when do you need to demonstrate compliance with Part L2A, and how does an EPC fit into this?

A design stage SBEM calculation is required to be submitted to Building Control before any work commences on site, and a second submission is required within 30 days of completion of the building. There are some minor variations to this, these are covered later. Anyone trained to do so can provide an SBEM calculation. However, on the completion of the building an EPC is also produced and submitted. The EPC is produced from the SBEM software, and must be provided by a qualified Non Domestic Energy Assessor (NDEA), therefore it should be the NDEA that provides both the SBEM calculations and the EPC. This will ensure consistency, a degree of quality assurance because all NDEA's are subject to auditing of their work by their Accreditation Scheme, and to keep costs down. If someone other than a qualified NDEA provides an SBEM calculation, it will have to be completed again from scratch by the NDEA producing the EPC, thus being calculated twice and paid for twice.

What buildings are covered in L2A?

- Construction of new buildings other than dwellings – any commercial building, the obvious ones like shops, offices, warehouses and factories, but also hospitals and hotels, and rooms for residential purposes – student accommodation for example.

- Fit out works where the work is either part of the construction of a new building, or is the first fit out shell and core development where the shell is sold or let before fit out work is carried out.

- The construction of extensions to existing buildings where the total useful floor area of the extension is greater than 100m2 and greater than 25% of the total useful floor area of the existing building.

- If designing a building that contains both dwellings and non-dwellings, for example and block with shops on the ground floor and flats above, Part L2A applies to the shop, and the common areas of the flats (stairwells and corridors) if heated, whilst Part L1A will apply to the flats.

- If a building contains both living accommodation and space used for commercial purposes, the whole building should generally be treated as a dwelling and assessed under Part L1A, as long as the commercial part could revert to living accommodation. The main criterion here is that the living accommodation occupies a substantial portion of the total building, this doesn't apply if there is a small bed-sit in a large office building! Then Part L2A applies.

Outside of the above are Conservatories and Porches installed at the same time as the construction of a new building, these are assessed using ADL2B.

Exempt buildings

There are some non-domestic buildings, which are exempt, although with all these I have found it's worth contacting Building Control in your area as there are local requirements in various Core Planning Strategies that may supersede these requirements.

The main exemptions are:

- Buildings or parts of buildings primarily used as places of worship – if there are offices, catering facilities etc adjoining these they are not exempt, so a part building calc would be undertaken.
- Temporary buildings with a planned useful time of less than 2 years, if over 2 years then a calc would be required.
- Industrial sites, workshops and agricultural buildings with low energy demand, the energy demand is concerning the energy for occupants, not an industrial or agricultural process
- Stand alone buildings with a total useful floor area of less than 50m2.

Back to demonstrating compliance

What we do when we complete and SBEM calc and provide an EPC is to demonstrate compliance against 5 Criterion of Part L2A. These are as follows:

- Criterion 1
  The calculated CO2 emission rate for the building (The BER – Building Emission Rate) must not be greater than the target (TER – Target Emission Rate). As this is the main requirement of Part L this is mandatory, so an SBEM calc is required to meet this criterion.

- The other Criterion are strictly speaking guidance only, however, the compliance submission lists them on the submission document and showing a fail would mean that another method of demonstrating compliance would need to be found, it's a lot simpler in most respects to follow the guidance in ADL2A to meet these other Criterion.

- Criterion 2
  The performance of the building fabric and the heating, hot water and fixed lighting systems should achieve reasonable overall standards of energy efficiency.

- Criterion 3
  Demonstrate that the building has appropriate passive control measures to limit solar gains – the purpose here is to reduce the need for installed capacity of air conditioning systems in summer.

- Criterion 4
  The performance of the building, as built, should be consistent with he BER. Essentially this is dealing with the gap between performance as designed and performance as built, often with the latter being lower than expected.

- Criterion 5
  The necessary provisions for enabling energy-efficient operation of the building should be put in place.

Of the 5 Criterion above producing an SBEM calc will cover the Criterion 1 & 2 explicitly, will provide information for the compliance of 3 & 4, and does not cover Criterion 5 as this is essentially the provision of a Building Log Book, although a copy of the SBEM calculation should be part of the Log Book.

What is actually required to gain compliance – The details.

BER (Building Emission Rate) and TER (Target Emission Rate)

This is the main one, if the TER is higher than the BER the building fails, how you affect the BER is multi faceted, and having an understanding of what goes into to making the TER is also important, so that you know what you are up against.
The BER is made up of the design input that also goes into complying with the other criterion - achieving target U Values, air permeability figures, system efficiencies and type of heating, hot water, lighting etc. all impact on the BER figure, of course.

The BER and TER is a measure of the CO2 emitted annually, per square meter – kgCO2/m2/year.

The National Calculation Methodology (NCM) determines the TER, it's based on a minimum set of efficiencies for the M&E services, and also on minimum standards being met for thermal performance.
The TER is based on a building that is the same size and shape as the actual building, constructed to a concurrent specification as detailed in the NCM and determines the Notional Building.

What is important to note is that although currently an overall 25% improvement in CO2 emissions is required, this is across the whole non-dwelling sector, and in actuality some buildings are required to gain more than 25%, others less, depending on their type. However, we don't know from the NCM (National Calculation Methodology) which building types require more or less, its 'hidden' within the calculation. That said we don't really need to know either, once the TER is determined that's what needs to be bettered.

It is useful to know what affects the TER, particularly when determining what U Values or air permeability the building should be, amongst other information, because the values given to the Notional Building are not the same as those as minimum standards in ADL2A, in most cases they are lower in the NCM, so for example, you may have thought achieving a U value of 0.25 for the roof would be ok, but if it's a 'side lit' building, the NCM U value would be 0.15. That's a considerable difference in performance.

The NCM and how this affects the TER

The TER is determined by the performance of the Notional Building.
The Notional Building is automatically determined by the information input to the SBEM calculation as follows:

- The building will have the same size and shape and zoning arrangements as the actual building.
- Each space will have the same activity (office, toilet, store etc) as proposed for the actual building.
- It will have the same orientation and have the same weather data applied as the actual.
- Any heating, ventilation, cooling attributed to a zone in the actual building will be mirrored in the Notional.
- In the Notional Building the activity assigned to each zone determines if the zone will have windows, rooflights or no glazing, regardless of what the actual building has.

- The glazing areas are determined by the building type - if side lit, it will be 40% of the exposed façade or 1.5m high x full façade width.

- If top lit, 12% of the exposed roof will be made up of roof lights.

- Areas of high usage entrance, pedestrian and vehicle access are copied from the actual and determined as opaque. If the total area for these is less than the above for side and top lit, the difference will be made up in the Notional. If the area exceeds the above, it will be taken as is.

- The Notional glazing for side lit buildings is typical 6mm/12mm/6mm argon filled double-glazing, frame factor 10% and light transmittance of 71%.

- For a top lit building roof glazing is the same as above with a frame factor of 15% and light transmittance of 67%.

- Display windows in the actual building are not copied to the Notional.

The Actual building, the one as designed, will be input using the information provided by the designer, using plans and specifications. However, in many situations the information, particularly at design stage is not always known, although this also does also occur at the As Built stage, which frankly surprises me, don't they know what they built it from? Anyway, if information is not available SBEM will make assumptions and or use default figures, these are usually nowhere near as good as those actually installed, and certainly a building will not pass if relying only on these defaults. To illustrate the difference between the Notional Building and the defaults used in the Actual Building, I have compared the two throughout the next section. To help keep track of both, the Actual Building default references in SBEM are in blue text.

Building Fabric

The U Values specified in the Notional Building are listed below.

Roofs	0.18
Walls	0.26
Exposed floors and ground floors	0.22*
All Windows	1.80
Vehicle or large doors	1.50
Pedestrian & high use doors	2.20
Internal wall	1.80
Internal floor/ceiling	1.00

*If the calculated value is lower than 0.22 in the actual building, then this value is used in the notional Building.

Obviously for any new building the U values will be calculated from the specification, there are some default values based depending on which Building Regs are used, i.e. 2002, 2006, 2010 etc and a huge menu of construction types that can be chosen to which all have an assigned "default" U Value. These can occasionally be used, but generally are not very generous and should be avoided, with the exception of any internal non-heat loss floors and walls, which are usually ok.

Zones in the Notional Building that are assigned roof lit activities will use metal clad roofs and walls, as well as the thermal capacity and psi value of metal clad constructions where appropriate. This is because its assumed that most roof lit building types are going to be retail warehouse/warehouse/factory type buildings.

The Notional Building does not have curtain walling, even if its there is in the actual building.

Air permeability in the Notional building is set at 5m3/h m2 at 50 pa. The building Regs maximum is 10m3/h m2 at 50 pa, therefore, as there is a considerable difference between the two figures above, a specified and achievable figure for the actual building should be provided, and preferably lower than 10!

Non Repeating Thermal Bridges use Psi values (W/m2) as follows:

Type of Junction	Involving Metal Cladding		Not involving Metal Cladding	
Roof to Wall	0.28	0.42	0.12	0.18
Wall to Ground Floor	1.15	1.73	0.16	0.24
Wall to Wall (Corner)	0.25	0.38	0.09	0.14
Wall to floor (Not GF)	0.00	0.04	0.07	0.11
Lintel	1.27	1.91	0.30	0.45
Sill	1.27	1.91	0.04	0.08
Jamb	1.27	1.91	0.05	0.09

The figures above are what are used in the Notional Building, and if not using ACD's (Accredited Construction Details) the default figures are these that will be used in the Actual building. As can be seen all the default figures are worse than the Notional, therefore if ACD's are not to be used, this shortfall in performance will need to be made up for elsewhere in the design. Non repeating thermal bridges can have a considerable impact on the overall result, particularly when a lot of windows are used, due to the higher psi values of the lintels, sills and jambs and, with a large heat loss perimeter due to the high psi values for the ground floor/wall junction.

I have put a brief explanation of what ACD's, psi values and how they are used in Appendix 1.

HVAC System

To list all the variables regarding the Notional buildings HVAC system would make very dull reading and risk being quite repetitive, if the reader is really interested then I suggest reading the NCM for yourself. That said, there are a couple of points to note.

Whatever method of heating and cooling is assigned to a space in the actual building, will also be assigned to the Notional Building. Although the assumed operating efficiencies for the equipment used differs between a side and non lit building, and a top lit building, the values given to them are very achievable, and are often under what could be sensibly achieved in the actual building. For example, the heat generator SCop (Seasonal Coefficient of Performance) for a gas boiler in a side or non-lit building is 79.2% for space heating, and 83.6% for hot water heating. In reality, with additional credits awarded for controls, these efficiency figures can easily be improved upon by up to a further 10%.

Auxiliary Energy

Often the result is much higher in the actual building than in the Notional. Auxiliary power density is the sum of all the pumps and fans power density, its 0.30 W/m2 where the HVAC system provides only heating, 0.90 Wm2 if it involves air conditioning, otherwise its zero. Pump power density in the Actual building will depend on the type of HVAC system if the pump has variable speed control, and the type of sensors in the system.

If the ventilation system used also provides heating and/or cooling, the SFP (Specific Fan Power) is 1.80 W/l/s for central systems, and 0.50 W/l/s for terminal systems.
If the system does not provide heating and/or cooling, but does provide heat recovery, then the SFP is 0.90 W/l/s.
In the Actual building it depends on the type of system to be installed, as to how the calculation is carried out by the software, entering known SFP's is always preferable.

For local mechanical extract fans the SFP is 0.40 W/l/s, and if the mechanical extract is remote from the zone this is increased to 0.60 W/l/s.
In the Actual building the SFP default figure is 1.5, although the Building Regs minimum is 0.5 for new buildings, so in reality 0.5 is the figure to achieve.

There is no Demand Controlled Ventilation assumed in the Notional Building, there is an option for the actual building, and depending on the system there are 3 Coefficient figures associated with the system, if the actual figures are known these would be preferable.

Lighting

Lighting has an enormous impact in the final result achieved in the SBEM calculation, and is often above anything else the difference between and pass and a fail. Interestingly, it's usually the one piece of information I have to go back to the building designer and ask for, and the one piece of information that has not been fully considered. For now, I will just mention what the Notional Building is based upon, later I will explain more about how lighting affects the calc.
The Notional Building assumes a lighting efficacy of 55 luminaries lumens per circuit – watt, the resulting power density (W/m2) will vary depending on the activity and geometry of each zone modelled.

The following equation is used to model the power density per 100 lux,
2.11 + 0.008 x R + 0.069 x R2

Where R is the Ratio of the total wall area to the total floor area, where the maximum value for R is 8. The W/m2 per 100 lux figure is then multiplied by the illuminance level for the activity type, which is in the NCM database, and divided by 100.
In the actual building the same equation is used but the W/m2 figure is that as specified, usually better than what is in the NCM database.

A bit boring for non-maths type people, but important to know because what I usually get given for lighting is just the lamp type i.e. T5, or CFL and no other information. It's really important to provide not only lamp type, but wattage and planned lux levels which will allow the W/m2 figure to be calculated accurately. Whatever figures are input will be used in the actual building, lumens per circuit watt and the luminaires light output ratio can be used, or as mentioned above if only the lamp type is provided, the figures in the following table are applied. In reality with new buildings, using low frequency T8 or T12 will definitely not pass so I have left them out, why use them if there are better performing lamp types available that will achieve a pass? I have left the Tungsten and Halogen in for comparison purposes, the building is not going to pass if they were exclusively used, but some in moderation can be ok.

Lamp Inference Data – Luminaire lumens per circuit wattage per lamp type

Lamp Type	Side lit and non lit activities	Top lit activities
LED	27.5	33.0
Tungsten or Halogen	7.5	9.0
CFL or other Fluorescent	22.5	27.0
Metal Halide	25.0	39.0
High Pressure Mercury	22.5	27.0
High Pressure Sodium	35.0	42.0
T5	37.5	45.0

Zones in the Notional building which use activity types flagged as having daylight harvesting in the NCM database will be modelled with photo electric dimming, without back sensor and always on, parasitic power being 3% of the total load or 0.3W/m2.

Zones that don't receive daylight harvesting but are flagged as appropriate to receive manual switching, will be modelled with manual switching provided the floor area for the zone is under 30m2.

Finally, some zone activities will automatically assume display lighting is present unless we tell it otherwise, if it is assumed, the W/m2 from the NCM activity database is multiplied by 0.682, an adjustment between lamp efficacy of 22 and 15 lumens per circuit watt.
In the Actual building, display lighting will be defined in terms of average display lighting lamp efficacy for each zone, which will be pro rated against an efficacy of 15 lamp lumens per circuit watts. That said, any display lighting with an efficacy less than 22 lumens per circuit watt wont pass the building Regs, so its best to specify what the actual figure will be to ensure a pass. There is an option to assign automatic time switching control at zone level to display lighting which will reduce the energy used by 20%, so if the default option is used, it may pass if this is selected.

General Input Data

There are a number of general input factors which also determine both the Actual and Notional buildings within the SBEM calculation.

Buildings are assigned a Building Type and their corresponding Activities which are assigned to each zone by Use Class, as defined by the Town and Country Planning Order 1987. As mentioned previously, although the aim is to achieve a 25% reduction in CO2 emissions across all non-domestic buildings, not every building type will achieve this figure, some will be more, and some will be less. The Use Class assigned to the building will be part of determining to which level of CO2 reduction is most appropriate. Ensuring the correct Use Class or Building type is selected is therefore important.

Also mentioned above is the Side Lit, Non Lit and Top Lit buildings. Again depending on the Use Class selected it will determine which of the above will be assigned to the building. Side Lit buildings are typically offices, retail outlets etc. Top Lit would be warehouse and factory type buildings, and non it would be cinemas, theatres or shops within an enclosed retail shopping centre for example.

Finally, CO2 Emissions Factors also have an impact on the final results, the Notional Building and Actual Building will use the same factors, but its important to know what they are, Gas for example is still the middle ground, with electricity considerably higher and biomass considerably lower. Even though renewable technologies may be used, if their fuel is electricity, the fuel factors to be applied are therefore part of the CO2 emissions calculations. The full table is below:

Fuel CO2 emissions factors for non-domestic buildings

Fuel Type	KgCO2/kWh
Biomass	0.013
Biogas	0.018
Waste Heat	0.058
Natural Gas	0.198
Dual Fuel (Mineral + Wood)	0.206
LPG	0.245
Fuel Oil	0.297
Anthracite	0.318
Manufactured smokeless Fuel	0.344
Coal	0.350
Grid supplied Electricity	0.517
Grid displaced Electricity	0.529

Hopefully the above should provide some clarity of how the Notional Building is formed within the SBEM calculation, and provides a better understanding of what level of performance needs to be achieved by the Actual as designed building in order to achieve a pass.

One final mention from the NCM database is that of the Reference Building (blimey, there's another one?!) This is another building within the SBEM software that is used only when producing an Energy Performance Certificate (EPC). When an EPC is produced the results are shown on a rainbow bar graph as an Asset Rating. This is the CO2 emissions from the Actual Building in comparison to a Standard Emission Rate and this is determined by applying a fixed improvement factor to the emissions from a Reference building.

The Reference building does not apply when assessing a building against the Building Regulations, this is the Notional Building and which the Actual Building needs to improve upon. The Reference Building is only used to calculate the EPC, however, as an EPC must be produced once the building has finished physical completion, it does play a part. All new buildings must submit an As Built SBEM calculation for Building Regulations, at the same time an EPC is also produced from the same file, there is no pass or fail of an EPC, the result is what it is.

The EPC was initially brought in for the sale and rental market to inform potential purchasers or tenants about the energy performance of a building, it was later extended to cover all new buildings. The EPC level is only important in this context, and it's also used as part of a BREEAM assessment. SBEM is used to provide EPC's for existing non-domestic buildings and the Reference building values are there to support that process with many of the data fields not applicable to new buildings*. See Appendix 3 for a sample EPC*

Lets get back to looking into ADL2A and what each of the Criterion means in terms of what you need to do to comply.

Criterion 1 – Achieving the BER.

The main point, in fact the only point, is that the BER must be no greater than the TER, and to demonstrate this an SBEM calc must be submitted to BCB before any work begins on site. The submission is the BRUKL document, a 2 or 3 page summary of the input produced by the software.

On completion and within 30 days afterwards, a further SBEM calculation is carried out, this time taking into the calc the results of an air pressure test, and making any changes as required that may have been made between the designed and as built building. This is also the time to confirm the as installed HVAC where in the design calc it may have only been generic information.

Emissions Factors

I mentioned these previously above, the Emissions Factors part determine the BER, so choice of fuel for the HVAC is very influential in the final result. Increasingly two fuels are being planned for use in a building, one as the main fuel, Biomass for example, with a gas boiler as back up, or the same appliance capable of burning two fuels. These are accounted for in the SBEM calc.

Enhanced Management and Control Features

The BER can be reduced slightly by the use of the following management features:
Automatic monitoring and targeting with alarms for out of range values – 0.050 adjustment on the BER
Power factor correction > 0.90 – 0.010 adjustment on the BER
Power factor correction > 0.95 – 0.025 adjustment on the BER
In practice these two features are rarely used but could help in achieving a pass but need to be incorporated into the design discussion at an early stage.

The above are two global, if you like, considerations into the building design, the rest of the design is entirely flexible, what U Values, air permeability, what HVAC systems and if any renewable technologies are to be used is up to the building designer, however, they are all interconnected. By that I mean that just because low U Values are achieved it does not necessarily mean that the worst performing HVAC system can be installed, or that poor U Values can be made up for in performance by installing solar PV for example. Its clear from the calculations that I have done that the influence of the M&E systems have a greater effect on the result than the fabric performance, and yet interestingly, and particularly for smaller units, the information for the fabric is provided in great detail but the M&E side is often very sketchy.

Shell and Core developments

If a building is being designed to market it at the shell and core stage, and the fit out work completed by the incoming occupier, the BER/TER still needs to be made. The submission, and the SBEM calc, will however show how that building could meet the energy efficiency requirements by assumptions made on the future installed systems.
In practice this becomes quite prescriptive, the building fabric and the U Values associated with it are as designed and often very little change is made to them. As long as they pass the minimum values required this is deemed acceptable. The issue then arises as to what HVAC systems are to be installed, as the emphasis is then solely on those systems as to whether a pass is achievable or not. Also, if the systems agreed at design stage do achieve a pass, how is it known for certain that the incoming occupier will want or actually install those systems?

A further SBEM calc is required once the systems have been installed and submitted to BCB so the emphasis is on both the incoming occupier and BCB to ensure compliance.

If the fit out does not include any provision for HVAC systems, then reasonable provision would be to demonstrate that any lighting systems installed are at least as efficient as those assumed in the shell and core submission.

Criterion 2 – Limits on Design Flexibility

This criterion as the title suggests is all about the limiting values set for both the building fabric and for the fixed building services. It states in ADL2A that in order to achieve the TER these limiting values will have to be considerably bettered, and its certainly true. If you followed all the minimum standards as set out below the building would invariably fail. So why are they there I hear you ask? Well you got to start somewhere, and elementally, taking each element on its own, these minimum values can and do contribute to achieving a pass, its just that by using them all its unlikely you will.

Fabric Standards

The table below sets out the minimum area weighted U Values for each element. In case your wondering what is meant by area weighted, if you have 3 or 4 different wall types, each with a different U Value, the area of each and its U Value are added together and divided by the total to get the average figure. On the BRUKL document used for Building Regs submissions, the fabric U Values are shown as the average, and the highest for each element. *See Appendix 2 BRUKL.*

U Values should be calculated using the methods and conventions in "BR 443 Conventions for U Value calculations BRE 2006" and based on the whole unit, likewise for windows it's the whole unit including frame and glazing.
I get a number of U Value calcs provided from various sources but in all cases I carry out my own calculations using approved software. There are two reasons for this, as an assessor I must be able to stand by all the input into the SBEM calc, and secondly I have found that sometimes the U Value calcs provided miss out essential corrections and therefore the U Value is incorrect. This can be a problem if it's later corrected and by doing so tips the building into a fail.

Limiting Fabric Values

Element	U Value ADL2A	Notional
Roof	0.25	0.18
Wall	0.35	0.26
Floor	0.25	0.22
Windows	2.2	1.8
Vehicle doors	1.5	1.5
High use doors	3.5	2.2
Roof ventilators	3.5	n/a
Air Permeability	10	5

I have included in the above table the Notional figures quoted earlier to give you a comparison. As you can see the Notional is some distance from the limiting figure allowed by ADL2A. Remember though that the figure taken into the Building Regs submission is an area weighted average, so although all U Values must be within the limits set above, some can be nearer the limit than others depending on the area. In reality I have found that achieving the Limiting values is very easy, and achieving the Notional values is also straightforward in terms of construction, particularly with the choice of insulation materials available.

For glazing and doors the values are very conservative with many off the peg solutions available, particularly now that for refurbishment the minimum U Values are lower than for new buildings, so manufacturers have made available products that meet those requirements as off the peg solutions.

The issue with U Values is that its ok to have these minimum values set, and achieving them is straightforward, but when it comes to the SBEM calc these alone will not guarantee a pass, and in my experience once you get lower than the Notional values the effect on the overall result is less of a return.

It's important to view the building as a whole, and the fixed building services have a greater impact on an SBEM calc and the resulting BER than the building fabric does.

Design Limits for Building Services

There are design limits for all the HVAC in the building, but firstly controls. The controls provided should enable reasonable levels of energy efficiency and the following would be appropriate for heating, ventilation and air conditioning:

- The system be sub divided into separate control zones that has a significantly different solar exposure, or pattern or type of use.
- Each control zone should be capable of independent timing and temperature control, and where appropriate ventilation and air recirculation rates.
- If heating and cooling is provided to a zone they should not operate simultaneously.
- Central plant should only operate when the zone systems require it, the default should be off.

All common sense stuff and not difficult to achieve in any building.

In addition to the above general requirements the systems installed should meet the minimum efficiencies as described in the Non-Domestic Building Services Guide (NDBSG). If a system were not in the Guide, then reasonable provision would be to demonstrate that the proposed system is no less efficient than a comparable one that is in the Guide.

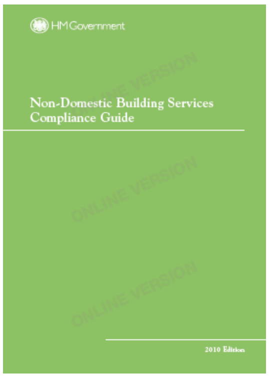
I'm going to explain what the NDBSG is and why it's important a little later, but first just to finish off Criterion 2.

Energy Meters

Energy meters should be installed that enable at least 90% of the estimated annual energy consumption of each fuel to be assigned to various end use categories like lighting, heating etc). That the output of any renewable system is separately monitored, and in buildings with a total useful floor area greater than 1000m2, automatic meter reading and data collection is in place. TM46 is a useful guide for benchmarking.

Centralised Switching of Appliances
Another global consideration should be given to the provision of centralised switches to allow the facilities manager to switch off appliances when they are not needed. Where appropriate these should be automated, with manual override, so that energy savings are maximised.

The Non-Domestic Building Services Compliance Guide (NDBSCG)



The 2010 Edition replaces any previous versions and also replaces parts of the 'Low or Zero Carbon Energy Sources: Strategic Guide', so if you have any of the old ones knocking about I suggest you recycle those and download for free the latest version from:
http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/bcassociateddocuments9/further

The Low or Zero Carbon document has been incorporated into the new NDBSCG, although certain sections of that document – PV, solar thermal and wind technology have not, however, guidance for all those that are included is quite basic.

There's no point me repeating what is inside the Guide, its 90 pages long, but I will provide a summary. It surprises me how many people do not know of this documents existence, let alone use it, for sure its invaluable to assessors because it provides guidance in terms of the input we need to enter into SBEM, however, it also a good general guide to the minimum requirements for most the HVAC and lighting in non-domestic buildings, and as such an excellent reference tool.

Basic contents are for each type of system, there is an Introduction to the technology, Scope of the guidance, Key Terms followed by technology specific guidance for minimum efficiencies etc.

It covers the following technologies after a general Introduction:
- Gas, Oil and Biomass fired boilers
- Heat pumps
- Gas and Oil fired warm air heaters
- Gas and Oil fired Radiant technology
- Combined heat and power & Community Heating
- Direct Electric space heating
- Domestic Hot Water
- Comfort Cooling
- Air Distribution Systems
- Pipework and Insulation
- Lighting
- Heating and cooling system glandless circulation and water pumps

There is a summary of the recommended minimum efficiency standards for building services in the introduction, a quick glance through it and you can see that the minimum efficiencies required are conservative, and most can be improved upon, particularly when the additional credits are used from applying those applicable to the various controls. The Lighting Section is very basic, with a description of what various controls mean, but otherwise it sets very basic limits on lighting efficacy of 55 lumens per circuit watt for general lighting, and 22 lumens per circuit watt for display lighting.
I will discuss lighting in more detail later, as its impact on the BER is considerable.

Criterion 3 – Limiting the Effects of Solar Gains in Summer

It applies to all buildings whether they are air conditioned or not and the intension is to limit solar gains during the summer months to either reduce the need for air conditioning, or reduce the installed capacity of any air conditioning that is installed.
Although definitely a section for Part L compliance, Criterion 3 is not really part of an SBEM calculation and cannot be assessed adequately with SBEM as the model. When the final BRUKL document is produced, from the latest version of the SBEM software, there is now a section that shows if there is an overheating risk in a particular zone. However, that is it, there is no way of directly influencing that result, other than the whole issue of ventilation and summer cooling being part of the design criteria.

Part L requires that reasonable provision for limiting solar gain through the building fabric would be to demonstrate that for each space in the building that is either occupied or mechanically cooled, the solar gains through the glazing aggravated over the period from April to September inclusive, are no greater than would occur through one of the reference glazing systems, each with its own defined solar transmittance or G - Value. Occupied spaces means a space occupied by one person for a period of time, so toilets and stores, circulation areas etc are not included.
These are detailed in the table below.

Reference Building Glazing Systems

Building Type in NCM	Reference Case	Frame Factor	G -Value
Side Lit	Full width East façade x 1m high	0.10	0.68
Top Lit- no higher than 6m	Horizontal roof of the same area with 10% glazed rooflights	0.25	0.68
Top Lit – greater than 6m	Horizontal roof of the same area with 20% glazed rooflights	0.15	0.46

What does this actually mean? If the above is the reference building then this is the minimum that any as designed building is going to be required to better, it’s then demonstrated by the section on the BRUKL as detailed above. However, in reality what happens in many cases is I carry out the SBEM calculation, produce the BRUKL document, and this is the first time any warning that overheating is a risk is realised, usually it has to be said on small buildings where the same level of detail in the design is not the same as say for a school, large office area etc.
I do get asked when an overheating Risk is shown on the BRUKL what I can do about it, but in reality at that point its very difficult to say, its more a matter of this being considered much earlier in the design process. The addition of solar shading does help, but the inputs on this into SBEM are limited, and of course reducing the glazing area will also help. SBEM is a compliance tool, not a design one, and will only produce results based on the input provided, against the Notional and Reference Buildings to which they are being assessed.

Introducing solar shading to reduce the risk of overheating may have an adverse effect, i.e. an increase in the heating required due to the reduction in useful solar heat gain. This in turn may require adjustments to the thermal construction efficiencies, i.e. lower u values, and adjustments to the HVAC efficiencies i.e. higher, to account for the increased heating requirement.

Criterion 4 – Building Performance Consistent with BER

What we are talking about here is that what has been designed, does in fact stand up in reality with the building as constructed, or at least as much as possible.
There are two SBEM calculations carried out for all buildings, one at design stage and submitted to Building Control before works starts, the second is submitted after the building is physically completed, and includes all the same input as for the as designed one, except that any changes made between the as designed and as constructed are taken into account, along with the result of an air permeability test.
The following details what would be reasonable provision to demonstrate compliance.

Building Fabric

What this whole section describes centres around reasonable quality of the building fabric and in particular continuous insulation and air permeability. The problem is that entering this in iSBEM has fairly limited data entry, so unless BCB are going to be checking the design drawings and specification, and perhaps more importantly how these are being built on site, its difficult to prove how good the building fabric is except in one way, air permeability testing.

Air Permeability does have an impact; aiming for anything over 5 in the test and it may be difficult to achieve a pass, even though the minimum required in L2A is 10. Linked to air permeability are the thermal bridging calculations. Repeating thermal bridges are taken care of in the main U value calculations, these are the corrections I mentioned earlier, and are for things like wall ties, metal fixings, etc. Other corrections for loft hatches, down lights and ground type are also taken into the U Value calcs.

It's the non repeating thermal bridges, those regarding the joins between wall and ground floor, the corners, joins between roof and wall, and the sills, jambs and lintels around openings that have been proved to have a considerable impact on the heat losses of a building if they are not designed, and probably more importantly, built carefully. These are input into SBEM in the thermal bridging field but the choices are limited, either a default psi value can be entered, which is usually the case in my experience, or if Accredited Construction Details (ACD's) have been used the psi value for each, or alternatively if a calculated psi value has been provided this can be entered although its subject to a 25% uplift.

If everyone followed the ACD route then compliance would more than likely be easier to achieve, and BCB would no doubt be very happy, seeing as providing the ACD checklist signed by the developer would be enough to prove that reasonable provision had been taken, and these would be supported by a good air permeability test result. However, although there are many ACD's available to choose from when designing junction details, and they are free to use, most architects seem to ignore them and design their own. Unfortunately, even though these junction details may be very good, and in some cases better than the ACD's, they are unlike the ACD's and therefore unproven and untested, officially at least for heat losses, so will only have the default psi values placed against them in the SBEM calculation.

ACD's do not have to be used for every junction, it could be that only some utilise the ACD, whilst others are as designed, those with the highest impact are the floor and wall junction, and around the windows.

Air Testing

An air pressure test must be provided in all new buildings, including extensions under Part L2A, except the following:

Buildings under 500m2 total useful floor area – provided the air permeability in the BER calculation in SBEM is 15m3/(h.m) at 50pa. If it is its unlikely to achieve a pass overall, or at least to do so there is going to have to be a considerable improvement elsewhere in the design, not a recommended approach in my opinion.

A factory made modular building with a planned lifetime of less than 2 years would be exempt as long as certain criteria are met regarding linkages between modules.

Large extensions where sealing off the join between the existing building and the new extension would be impractical – where this is so the building should be treated as a large complex building.

Large complex buildings do not require an air test if they meet the considerations as detailed din the ATTMA guidance. This should have been agreed with BCB at the design stage, and the air permeability figure entered into SBEM would be above 5.

Compartmentalised buildings – if a building is compartmentalised into self contained units with no internal connections, again the ATTMA guidance should be followed by providing a test on a representative area of the building only. Air permeability must not be worse than 10.

If an air test fails to meet the minimum requirements, either the Building Regs maximum of 10, or the design value, remedial measure will need to be made on site and retesting carried out until a pass is achieved, or in some instances other improvements made to make up for any shortfall in the BER/TER.

Commissioning of the Building Services Systems

Although this section is in Part L2A but it doesn't come within the remit of the SBEM calculation.

Air Leakage Testing of Duct Systems
There are 3 Classes of low pressure ductwork performance, A,B & C, its not important in terms of the SBEM calc as such, if its known what class the ductwork is then this will be selected within the calculation software. Only if the ductwork is claiming to be less leaky than the appropriate class should the results of a test be input instead of the assumed values.

Criterion 5 – Provisions for Energy-Efficient Operation of the Building

The only mention here is that the BER/TER should be included in the building Log Book, so a copy of the BRUKL document will suffice, and also a copy of the On Construction EPC with its Recommendation Report. Both are applicable only to the building once completed of course.

SBEM Input Fields

I have gone through the details of Part L2A, what is required in order to achieve a pass, and also how SBEM works in terms of how the Actual building as designed is compared to a Notional building within the SBEM calculation in order to produce the BER/TER calculation required by Part L2A.

In this next section I will discuss what information is required by an assessor to input into SBEM. The supply of the correct information in the right format is often a challenge to get hold of, usually because either the required information is not available, or when it is, it is in such a format that makes it very difficult sometimes to pull out the important information from what is not.
In many cases a Specification of 200 pages plus would yield about 15-20% of useful information regarding an SBEM calculation, and rest will be unimportant, at least to an assessor anyway. So, just for the record, anything to do with drainage, fire strategy and stair detailing, amongst other information is of no importance to an assessor at all, ever…. so those sections of a Specification can be dropped straightaway….please.

Assessors, Accreditation Schemes & the rules we have to follow

A quick word regarding the conventions we are obliged to follow. I think the first thing to say here is that all assessors, no matter which Accreditation Scheme they may belong to, are subject to the same rules and conventions in terms of producing SBEM calculations and EPC's. Each Scheme is obliged to audit at random a number of reports produced by assessors and check them for accuracy, there are clear rules as to what is tolerable (2 EPC points and 6% BER) and if any report is found to be incorrect and outside of the tolerances, a revised report may have to be submitted, an assessor may have to undergo further training, and in some severe cases an assessor may lose their license to produce reports.

There are also Conventions that every assessor must follow to produce a report, these are a set of rules regarding how to interpret and input the information supplied, from how to measure a building to determining various input for Electrical & Mechanical services. All are agreed upon by the Commercial Energy Performance Certificate Conventions Group, and adopted by all Accreditation Schemes. The conventions are there to improve the accuracy of the reports produced by ensuring that all information is input to within the same parameters, so for example, if one assessor measured a zone using the outside of the external walls, an another measured using the internal surfaces, two different results would occur. By following the same convention to measuring, the same results will likely occur. (It's to the internal surface of an external wall in case you were wondering).

All Schemes (well the ones I belong to anyway – CIBSE, NHER, BRE) keep their assessors up to date regularly with Technical Bulletins and newsletters, which are designed to show the conventions, which must be put into practice, and all schemes require their members to do CPD training throughout the year. Finally, the Conventions themselves are updated and changed once or twice a year and must be implemented from a given date.

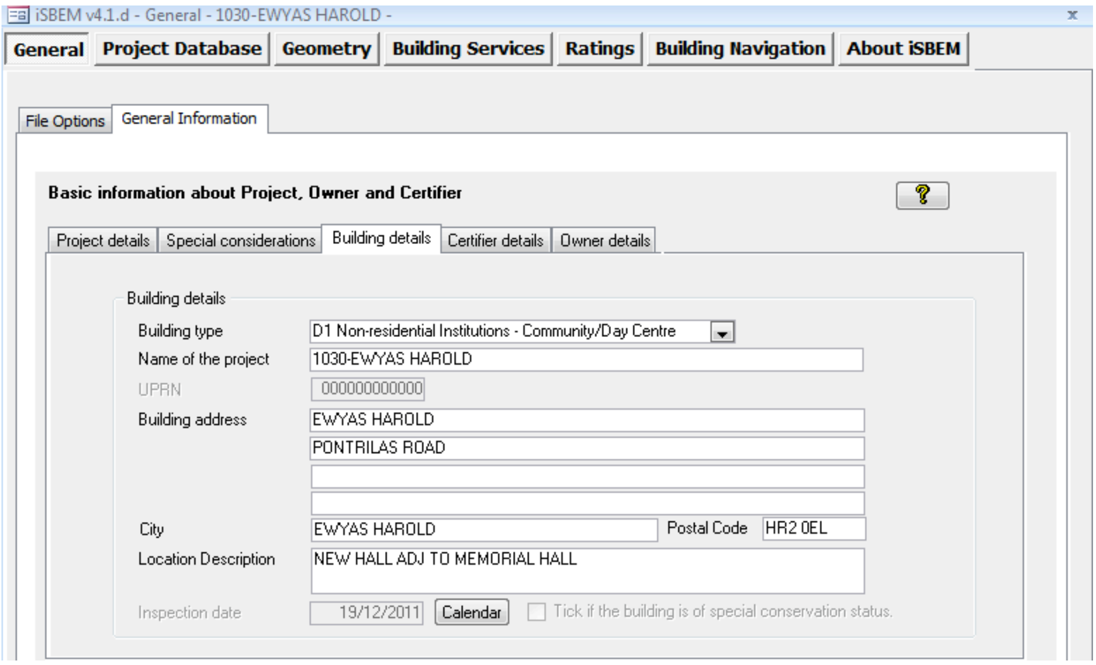
On a side note, I have had many reports pulled in for quality checking in an audit, in some instances they have been highlighted as exemplary. I view auditing as a necessary part of the job and from the feedback provided it can only help to produce better reports.

What information is required to input into SBEM – and what are the results of doing so?

General Information

Building Address with Postcode – seems obvious but this is not provided on so many occasions and apart from ensuring that the address on the report is the right one, something that if its not on the Landmark database will need to be requested, and the postcode will be used to determine the weather location in SBEM. This can influence the result because weather locations are based upon degree data, so we don't want to get our BA mixed up with BB because Bradford on Avon and Bradford have very different weather. It won't affect the overall result very much at all, but it will just a bit and its embarrassing when the address is somewhere other than you thought it would be, my geography is ok but I might not know where your building is situated.

The other initial input is the Use Class of the building, this is used to determine the building type of the Notional Building, amongst other things, so it's important if possible to input the correct one although ultimately it's the individual zone activity type that has a greater effect on the overall result. However, Building type will affect the overall result, even if to a small degree.



Screen shot of the initial input data into SBEM.

Use of Defaults – within the SBEM model there are default entries for virtually all the different fields, if an assessor does not input something, a value will be assumed by the software, however, the conventions are that default values in SBEM should only be left to stand in the absence of any other information available. The expectation is that a true figure should be input, and increasingly as the conventions are updated this is coming through more and more strongly. Personally I think this is the way that compliance with the regulations will be tightened up, because if all we as assessors can input are true figures, then the emphasis will be on designers to provide those figures by factoring more detail into the design.

For large projects this is usually the case anyway, but for small-scale projects often the details for the M&E is sketchy at best, relying on assessors to provide some sort of input as to what will pass. This is something we can and do provide, but ultimately many of us are not trained building designers, we can say what will pass from a compliance point of view, but whether it will be a practical solution that works in reality and will meet all the demands of the occupants is unknown, unless those producing the calculations are also trained architects or building services engineers. I think there is good reason to have the roles separate; both can focus on their particular skills and for the assessor, to be a good reference point for the architect and building service engineer.

For new builds there are hardly any input fields that would need to remain at default entry level, for existing buildings producing EPC's then it's the other way around as there is often very little information available and the defaults are all there is. This is an issue with using the same software to produce reports on two very different situations; it only applies to EPC's, Building Regs compliance of course in this context only applying to new buildings.

Structure of SBEM objects

After the General Information tab there are a further 4 main tabs – Project Database, Geometry, Building Services & Ratings, under which are a number of sub tabs available for input into SBEM. This section will go through each tab to identify what input is required from the designer, what happens if no information is available, and the effect of varying input.

Geometry

I have taken these tabs out of sequence to as they appear in SBEM, Geometry is actually the second one but there are some details to understand here that will effect how the whole building in the SBEM file is structured so its important to state them early.

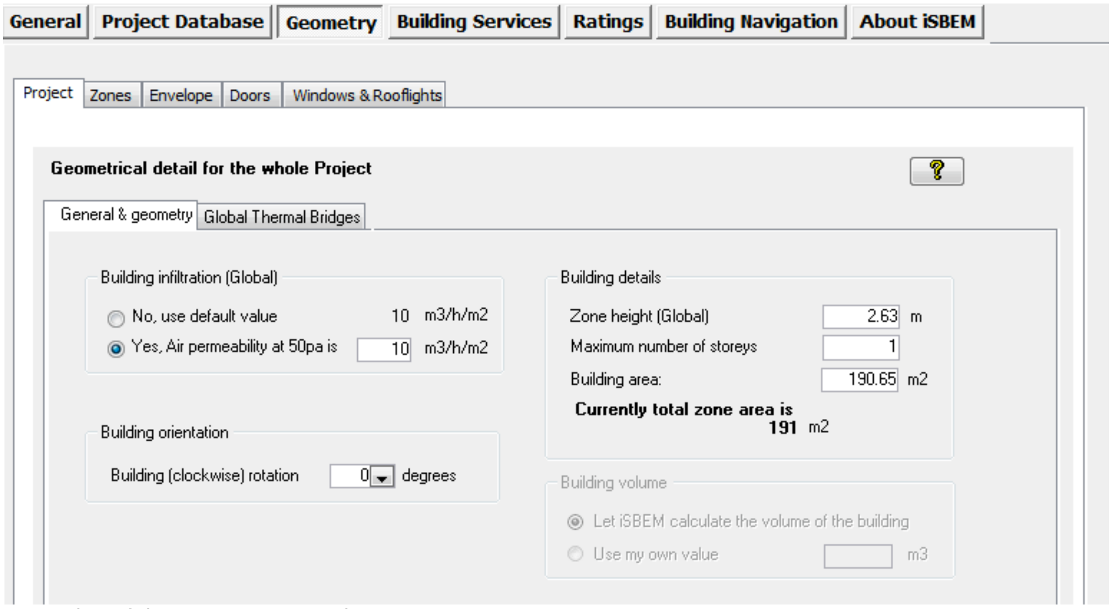
The building in SBEM needs to be divided up into zones, and each zone is determined by a number of factors. Firstly by its activity, in SBEM there is a list of activities – offices, classrooms, workshop, retail space etc depending on the building type selected under the General tab. Usually whatever is selected in the General tab, say B1 Offices and Workshop Business, then all activities associated with this building type can be selected, however, if the building has an activity that is not listed under B1, we are free to select another building type, maybe A1/A2 Retail and Financial/Professional services, and choose an activity that is more suitable from that list instead.
There are 23 different Building Types to choose from, all based on the Use Classes, and in each there are a number of Activities to select which best describes the zone. There can be a marked difference in the end result depending on which building type is selected.

In determining a zone this is usually by room type, and by what room is immediately adjacent to it. For example an office could be next to a corridor, storeroom and another office. The two offices could be joined together to make one zone, the corridor and storeroom would be other zones.

As can be seen from the above its important to know at the very earliest stage what each activity a room is likely to be so that accurate zoning can be completed.

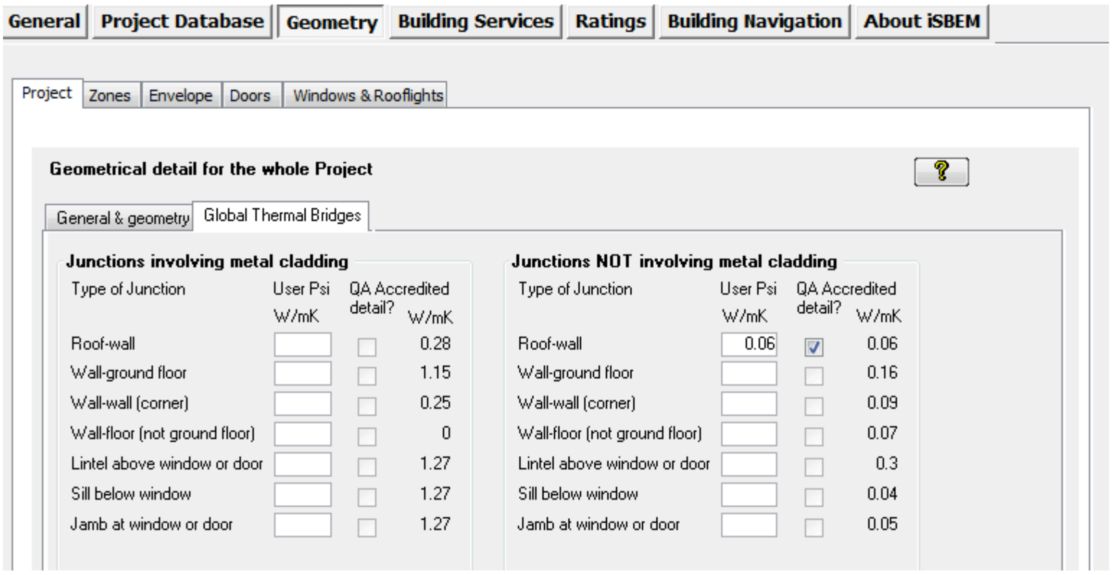
Once the Activity is established the second factor in determining a zone is the HVAC, is the room to be heated/unheated, by what system, is there hot water present and the system to provide it, is there mechanical ventilation/extracts and what systems, and finally what lighting is present in each room. All the above will determine if rooms can be joined together to form zones or whether each room will be need to be a separate zone in itself. If the two adjoining offices above have different heating/cooling, hot water, mechanical ventilation or lighting, including lighting controls, then they will need to be separate zones, if the same in all respects then they can be joined into one zone.
If completing this at a stage where this is unknown, I err on the side of caution and allocate each room to a separate zone. The issue if this information is unavailable at an early stage is one of cost of the assessment, the more zones to input the higher the cost of the assessment.

In the main Geometry tab there are some global inputs, which will be applicable to all zones, Air Permeability – for design stage calcs this is the proposed figure, for as built this will be the result of an air test. Obviously this does have an effect on the overall BER result, and often for smaller scale projects this is left to be the maximum allowed of 10 m3/h/m2, however, the air permeability can have a significant effect on the final BER.



Screenshot of the Geometry main tab

Other global inputs here are small details only and won't affect the calculation.



Screenshot of the Geometry Global Thermal Bridges tab tab

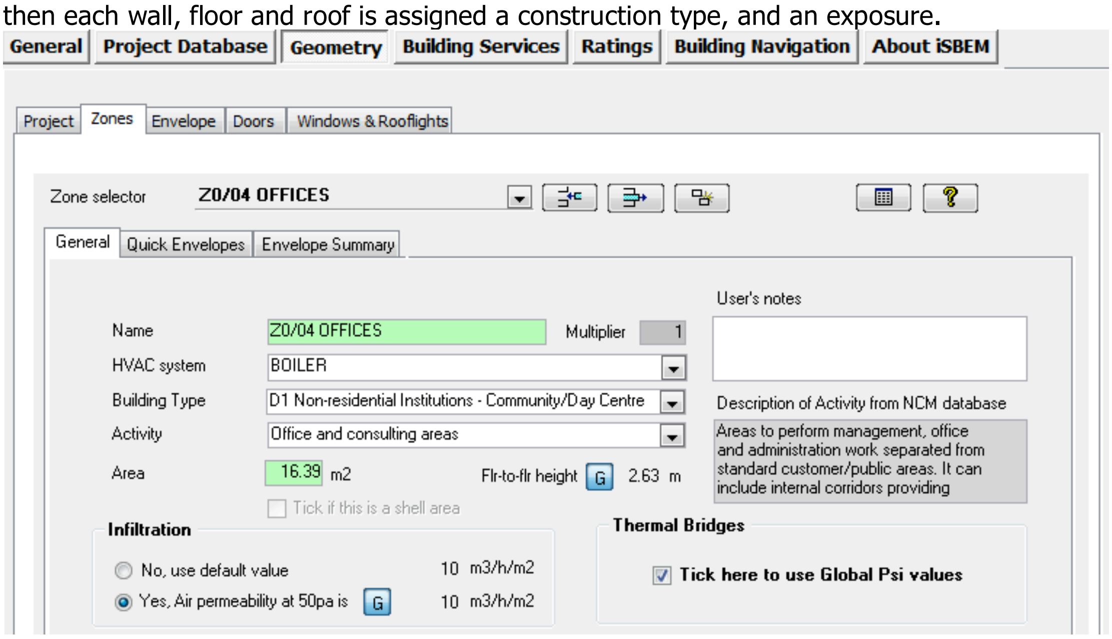
The second sub tab is for Global Thermal Bridges, which is split into two fields, one for junctions involving metal cladding and the other for those do not. The input is simple enough, if using Accredited Details for any junction then the relevant box is ticked, if using an independently calculated Psi value, that value is entered instead.

In my experience this is one of the least used input fields, and one where the result if it was used would have a significant effect on the overall BER result. Most designs do not use ACD's, instead the details are the architects own, nothing wrong with that at all but it does mean that the psi values attributed for all the linear thermal bridges are double what they would be if ACD's were used.

Thermal bridges cannot be taken in isolation, they work hand in glove with the thermal elemental U Values and air permeability figures, but generally, and I emphasise generally, if ACD's are not used then U Values will have to be low, and the air permeability figure needs to be realistic rather than optimistic. Bare in mind that the Notional Building is set at 5, whereas the Regulations minimum is set at 10.

The other sub tabs under the Geometry main tab are for inputting the zone envelope details, including all openings.
This is based on how a zone is actually constructed in SBEM. Essentially each zone is a six-sided cube, it wont be a nice symmetrical cube in most cases, it would be great for the SBEM calculation if it was but would probably make for some very boring buildings!

Each zone is determined an Activity, Heating/cooling/hot water/lighting and controls, and then each wall, floor and roof is assigned a construction type, and an exposure.



Screenshot of the General data entry for a zone

Zones are not always straightforward, it could be curved, or be shaped like an 'L' a 'T', 'F' or 'E' , anything really, but what is important is that each envelope is assigned the correct construction, exposure and orientation. If we take the 'E' shaped room there could be up to 12 different walls entered depending on what they are adjacent to. If a wall in one orientation is partly exposed to the outside, and an unheated zone and a heated zone then that's 3 different inputs for just one wall.
For each wall input not only is the area of the wall required, also required is the perimeter length.

Usually the floor is only of one type but if this is a first floor part could be exposed to a conditioned space below, another part to an unheated space. The area of each floor is entered and also the pitch if required.
The roof could be part ceiling, part flat roof and part pitched roof, again for each type the area is input along with the relevant pitch. If the roof is curved, if the ceiling is dropped, if the ceiling is part way up a pitched roof or if there is a sloping ceiling, say under an auditorium, all these variants can be modelled in SBEM but there are conventions as to how they are measured.

It sounds unlikely but in reality the different types of a wall, floor or roof etc in the same envelope happens a lot, and what would seem like straightforward zoning in a building becomes a very complicated one once the details are finalised. Obviously an assessor will look to minimise the building into as few zones as possible so that the input is reduced, not

only from a practical point of view in terms of time to do the job but also to reduce the likelihood of mistakes and to make the project easier to check and refer back to.
Its important for an assessor to gain an overview of the whole building wherever possible, the construction, the activities assigned to each room, and the HVAC and lighting to be assigned to each room so that accurate zoning can be completed at an early stage.

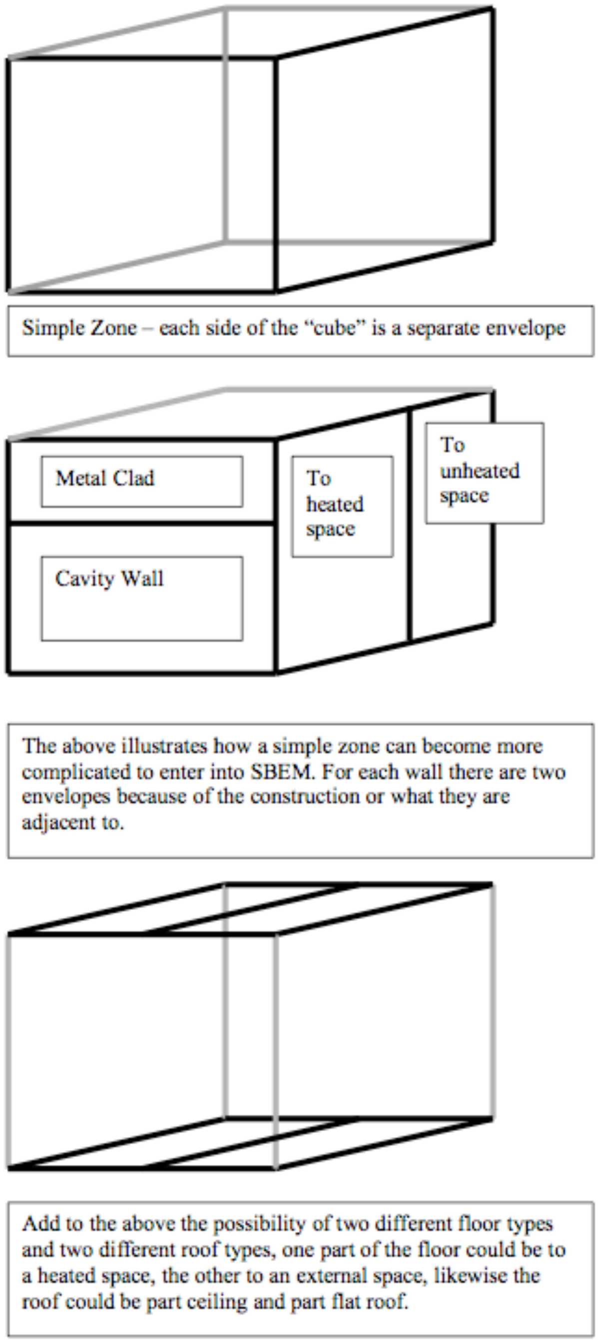


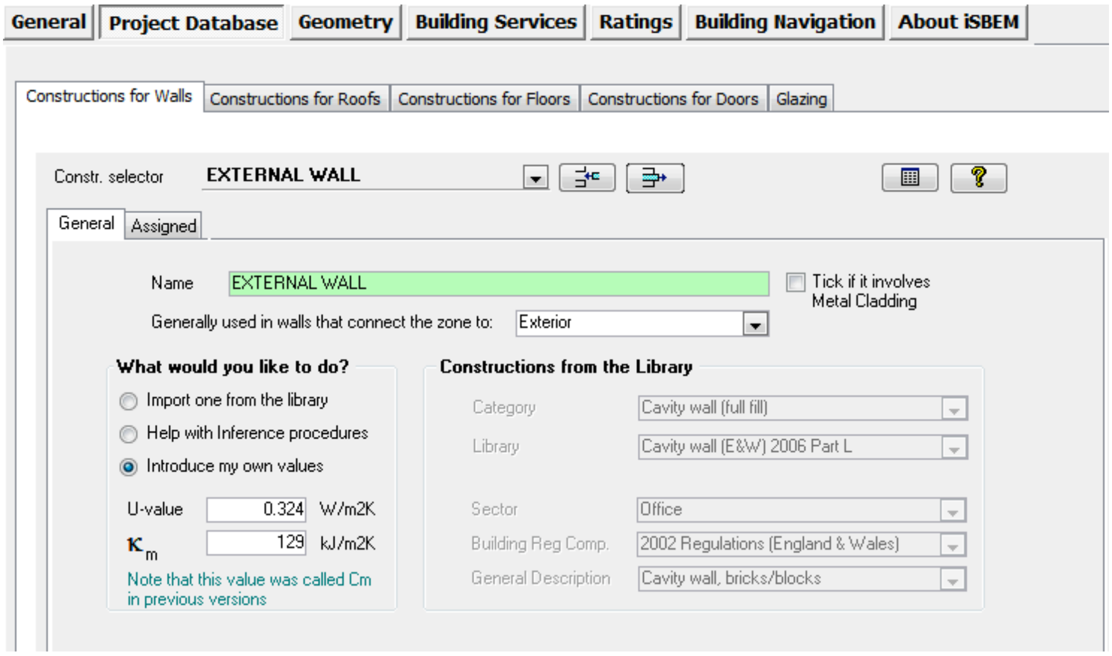
Diagram of how a zones envelope can differ depending on the number of different types of construction

I have tried, with limited success on my part but with great success from the clients point of view, by zoning up a building and inputting those zones into SBEM, but leaving the elemental details vague, so things like the actual U Values for the envelopes and the exposure of each envelope are defined but subject to change. The advantage to the client is that this allows trying out different U Values to see what works best, but once the design is then finalised and the various constructions and their exposure are defined it often results in what was thought to be one wall with one type of exposure changes into maybe two constructions or two different exposures, with changes required on the initial input and an second input made to account for the other construction or exposure. The result is a greater chance of mistakes or something being unaccounted for. Better would be the input all at one point when the details are known and can be provided. I understand the client's needs for this kind of approach, but its a lot more time consuming and will therefore increase the costs of producing the reports.

In summary of the Geometry tab, we have to divide the building up into zones that have the same activity, the same heating/cooling, hot water, mechanical ventilation/extract, lighting and lighting controls.

Project Database

This is where details of the constructions are input, essentially for every wall, floor, roof, window and door it requires inputting the U Value of each different type.
At this point it's important therefore to have an understanding of the constructions to be used in all the external envelope, even if the finer details are yet to be worked out.



Screenshot of the Project Database screen for input of each construction type

Within each of the tabs there are a number of choices, if I take an external wall for example. The first input is to name the element, Brick Cavity Wall for example, and determine the exposure – Exterior, Conditioned space etc.
There are then 3 options to choose a database of wall types;

Import One from the Library i.e. Category could be Cavity Wall full fill, and Library could be Cavity Wall 2006 Part L.

Help with Inference procedures – i.e. Sector could be Office, Building Reg Comp could be 2006 Regulations, General Description could be Cavity wall, bricks/blocks.

With both the above its likely that the result will be the same, in all the constructions it's the U Value which is the important factor, if the above choices are made a U Value based on a generic cavity brick/block wall meeting the 2006 regs, this case 0.35. Its hardly the best basis to form the construction of a new building, its fine for existing buildings when an EPC only is to be produced, as often detailed documentation regarding construction is long gone, so determining what the construction is and putting an appropriate construction date to it and therefore the appropriate Building Regs date, to determine an approximate elemental U Value is fine.
For new builds if we remember back to our Notional Building values, a wall is 0.26, in the current Building Regs the minimum value is 0.35, so although by using the either of the two options above will meet the Building Regs, its unlikely to achieve a pass overall because what you are up against is in effect 0.26.

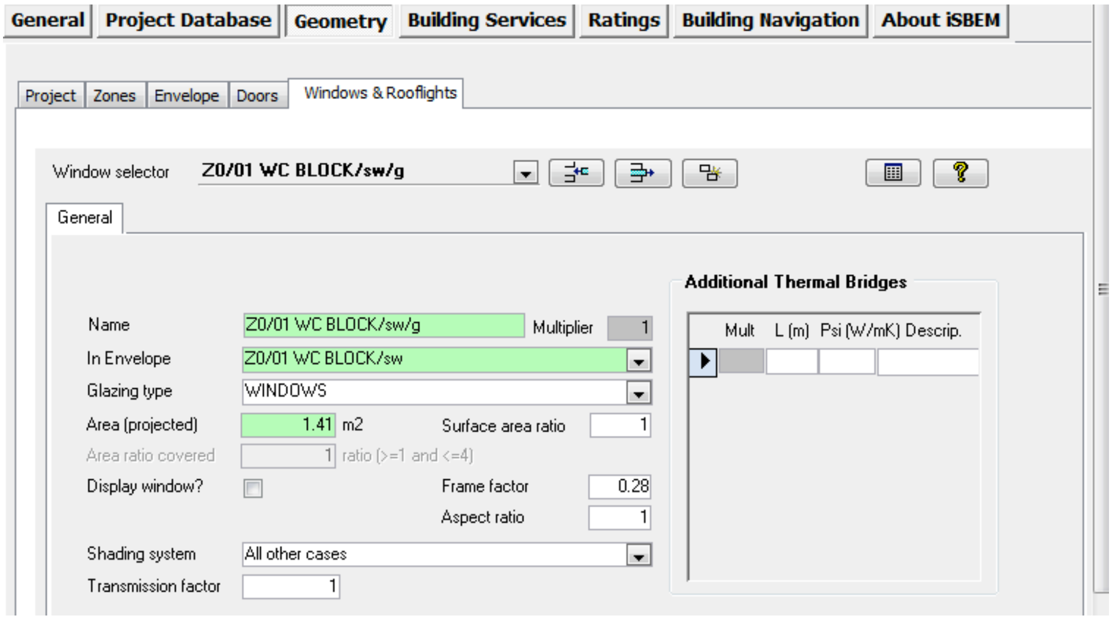
The Third option and by far the best, as shown above, and in my opinion the only one that should be used when using an SBEM calc to demonstrate compliance with Part L, is the 'Introduce my own values' – this is where we input the calculated U Value W/m2K and if possible a Km value kj/m2K. This is the most accurate of course because it is an input of the actual design in detail, however, its interesting the amount of times where the calculated value is actually worse than the default figures when using the first two options. I think this is mainly due to where a calculation has been carried out by untrained people who don't follow all the rules for corrections and other factors that need to be taken into account when doing a U Value calc. All level 4 assessors are qualified to provide U Value calculations in accordance with "BR 443 Conventions for U Value calculations BRE 2006".

The above applies to floors, walls, roofs and external doors, for windows the same also applies except that there is an input field for both T Solar and L Solar values. I very rarely get these figures at all and nearly always rely on the default value dependent on the type of glazing chosen, it doesn't seem to affect the overall calculation.

Windows also have a number of other inputs:

- Area of each opening
- The Aspect Ratio which is the height divided by the width of the opening.
- The Frame Factor – this is the ratio between the amount of glazing and the total frame, each needs to be calculated.
- Finally, if any form of external shading is present the effect of that shading also needs to be entered using a simple formula having the measured the depth of the overhang or fin and the angle from mid height of the window to the edge of the shading device. These inputs are important because they will affect the solar gain calculation, could certainly affect the overall BER, and will affect the recommendations in an EPC.

To work these figures out correctly a window specification showing all the dimensions and the glazing panels is essential.

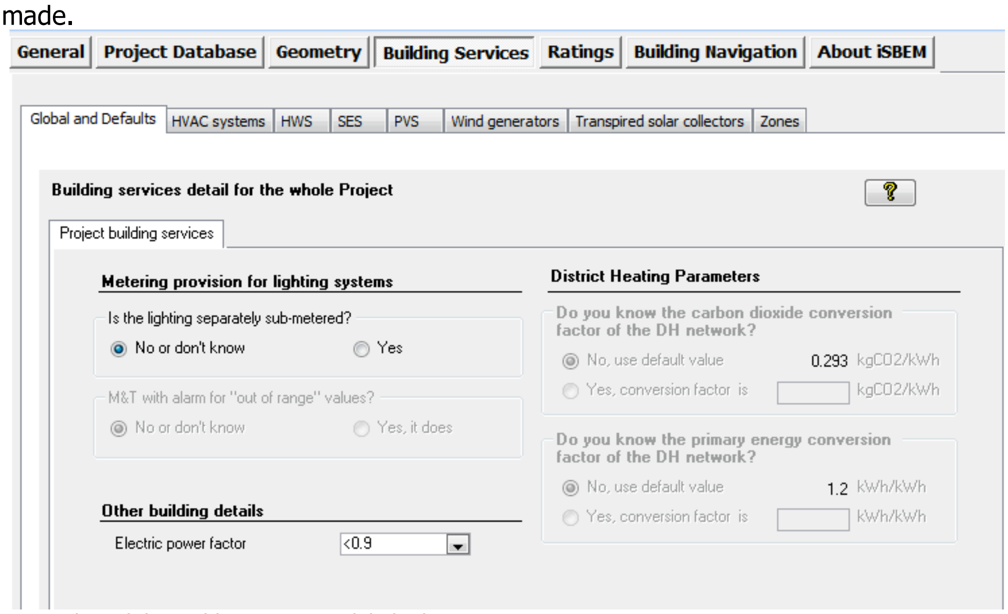


Screenshot showing the Project Database Windows & Rooflights sub tab

So to sum up this section on the Project Database, before we carry out the SBEM calculation we need details of each construction in all the external elements so that we can calculate the U Value of each. We are interested in heat loss, so I think I may have mentioned this before, but stair construction details and the like we will never want to see, ever….

Building Services

This tab has the most sub tabs and therefore the greatest number of input fields into SBEM. Since the change to the 2010 regulations the impact of the building services on the overall SBEM result has increased, I think there has been a realisation that of course the equipment used in a commercial building will have a far greater effect on the C02 emissions than the thermal elements. That said the envelope is still a very important factor, and reducing unwanted heat loss from a well designed and built structure is a key element to ensuring that the installed equipment performs to the level of efficiency and costs that were expected at design stage. However, there is a threshold where no mater how low the U Values and air permeability are, the effect of further improvements on the BER are less and less, and attention to the mechanical services is where the real gains in building performance are to be made.



Screenshot of the Building Services Global tab

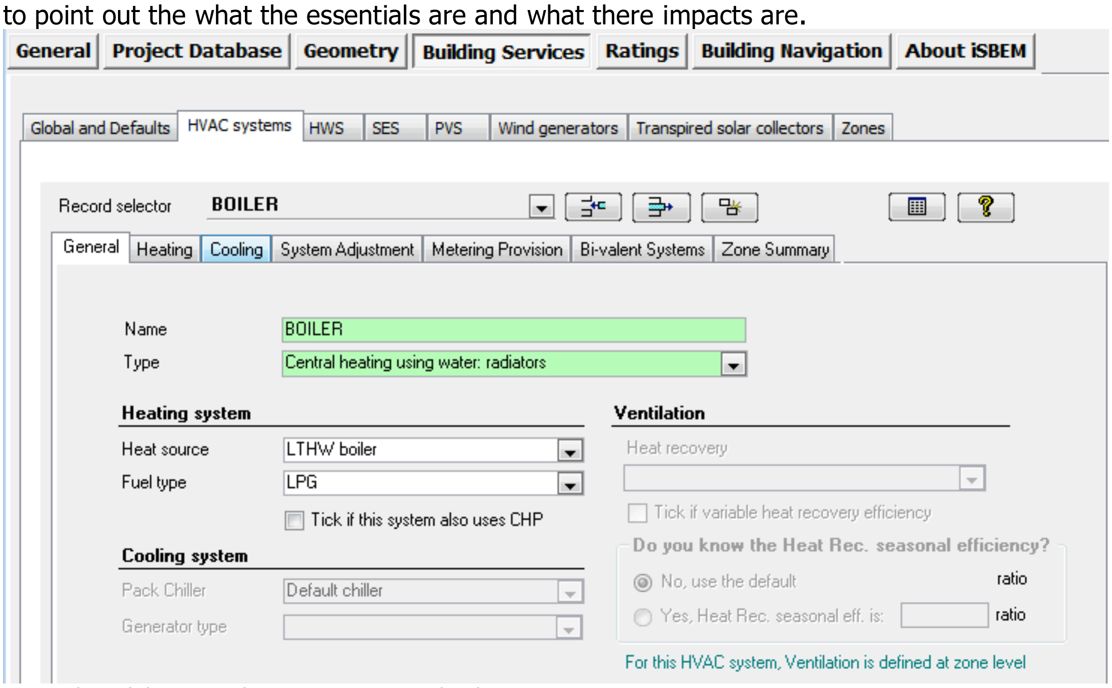
This section also has some global inputs available, the first being the HVAC system details tab – usually this is ignored for new builds except when the building is a Shell & Core fit out. Here there is a choice to determine the fuel depending if a zone is heating only or heating and cooling. In reality if the SBEM result relies on these global defaults only it has very little chance of a pass, instead if a shell and core fit out is required its better to determine a heating system appropriate to the type of building. The only other time these inputs are used is with an existing building EPC.

The other two global inputs are Air Conditioning present or not – if it is then we need to say what the total effective output is in kW, and if over 12kW has an inspection been carried or is planned. This is only for when an EPC is to be produced and is used by Government to determine the extent of how many air conditioning systems are requiring assessment.

Finally a couple of global inputs for the building – 'Is the lighting sub metered or not', 'Is there M&T with an alarm for out of range values', and 'What is the Electric power factor', if different to <0.9.
If the first two are selected as yes, and the electric power factor selected over 0.9, this will lower the BER slightly but otherwise their impact is minimal.

There is also an input for District Heating Parameters for CO2 conversion factors if appropriate.

HVAC Systems Tab
This main tab and its sub tabs are where, no surprise, all the information regarding the HVAC systems are input. I am not going to repeat what every input is required, more important is to point out the what the essentials are and what there impacts are.



Screenshot of the General Heating Systems sub tab

There are 26 different HVAC systems to choose from, and in each of those different details to input depending on the system chosen. Every zone in theory could have a different HVAC system, there is a possibility to add as many systems as are appropriate.
Each is given a name and a type assigned to it i.e. Name: Vaillant Eco Tec 624 and Type: Central heating using water: radiators.

Heat Source is defined i.e. LTHW Boiler, and Fuel Type i.e. Natural Gas, LPG etc

If the system is one that may have cooling too, then the Cooling system tab is highlighted and the Pack Chiller and the cooling Generator Type can be input.

Likewise if the system includes ventilation, like a VAV system, then the type of Heat Recovery can be entered i.e. plate heat exchanger (or none if appropriate) and the Heat Recovery seasonal efficiency ratio.

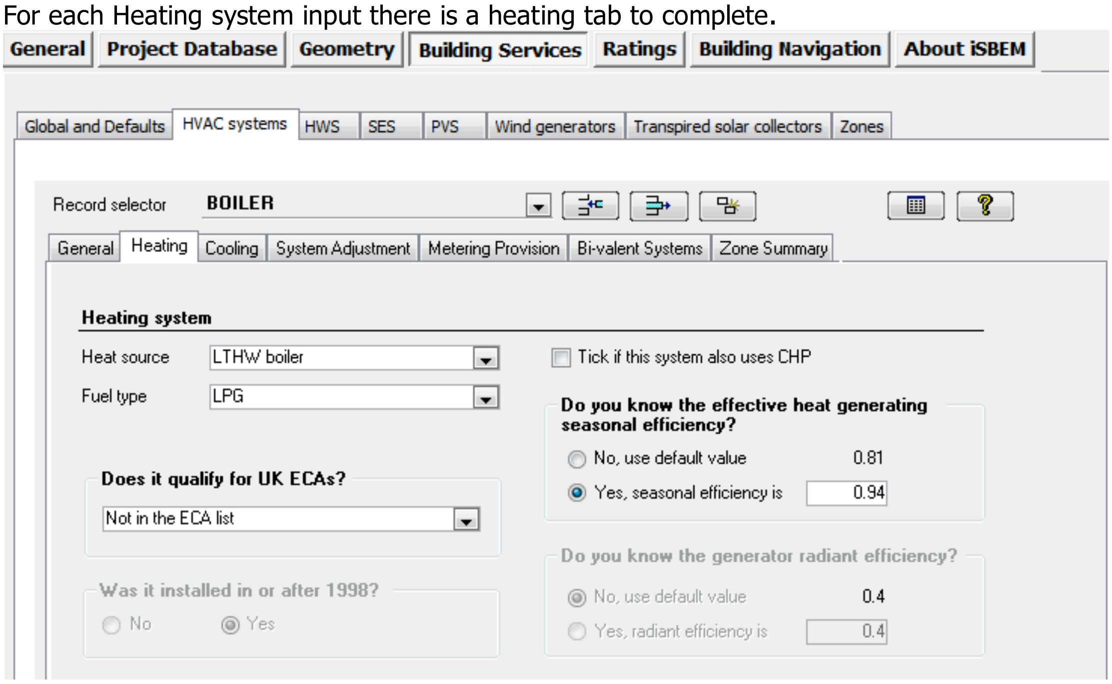
All the above is straightforward enough, except that for almost all SBEM calcs I carry out which includes the above I usually have to go back to the designers and ask for some information.

To sum this small but important section up we require the following information:

- Heating/Cooling systems – their name and model number
- The type of system – it should be obvious but sometimes not, a VAV system could be single duct, dual duct of an Indoor packaged cabinet
- Heat Source – they are not always a low temperature boiler!
- Fuel type
- Cooling system type – heat pump or water/air remote-condenser chiller
- If ventilation, does it have heat recovery, the type and its seasonal efficiency

The type of system, choice of fuel and any efficiencies do affect the overall BER result so its important to get these correct, Building Services engineers know exactly what they are talking about, but getting that language to meet the language in SBEM can sometimes be difficult, I don't understand why they should be that different, but sometimes it feels like one is speaking Spanish and the other Portuguese, they sound similar but they are different. The choice of heating system will be up to the those involved in the design, however, any fossil fuel based system is going to be poor in performance compared to those using bio fuels or electric heat pump systems with their high SEER/EER values.

For each Heating system input there is a heating tab to complete.



Screenshot for the heating sub tab where the equipment efficiencies are entered

Heat Source and Fuel type again will be the same as the Systems tab

'Does it qualify for UK ECAs?' This input is the Enhanced Capital Allowance list of products. Its unlikely that the designer of the system will know if its on the ECA list or not, at least that's my experience anyway. There are advantages to selecting a product that is on the list because there are tax relief benefits for the organisation who uses the products. Finding the product in question can be a problem, however, if it is on there the most important information is the operating efficiency figures for the equipment. All efficiencies need to be Gross figures, so if they are provided as net, we will need to convert them.

If the system uses CHP – just a tick box to determine yes

'Do you know the seasonal efficiency?'
If the default value is used this is a very low figure and will not help in the overall BER calculation, some are lower than the minimum required by the Part L, therefore if the heating equipment is not in the ECA list its very important that the efficiency figures are known.
If the actual equipment is known then these figures can be found out either from manufacturers/ suppliers etc or the designer of the system.
One of my main frustrations in this respect is one, not being supplied with the figures in the first place, but also in the main with heat pump suppliers etc who have copious listed information on their websites regarding their equipment, especially 'Technical details' but the one thing they miss out is the seasonal efficiency figures, and things like SFP figures. In both non-domestic and domestic applications and to satisfy Part L, the only information that is relevant to Part L compliance is the seasonal efficiency and SFP figures, and these are often missing or difficult to find! (Rant over)

There is a strict hierarchy we assessors need to follow in order to gain the correct efficiency figures:

- Use the ECA list part load values at 30% and 100% and then calculate the seasonal efficiency.
- Use the ECA list full load value if part load is not given
- Use current SEDBUK values
- Use either manufacturers or 'boiler plate' information to determine the efficiency
- Use SAP values
- Use SBEM default

The most important information to gain is the exact make and model of the system, and then its efficiency figures from one of the sources listed above.

The final input under heating is 'Do you know the Generator radiant efficiency?' Applicable to radiant systems only and again the default value is not a generous one.

As with all efficiency figures these can be improved by adding the appropriate efficiency credits depending on the controls to be used with the system, up to a maximum of 4 additional percentage points, therefore knowing the intended controls are important too. There is a separate tab to enter the information for controls mentioned a little later.

To sum up this input required – Seasonal Efficiencies – its really important to know how efficient the system is because the more efficient it is will improve the BER result. Stating the obvious perhaps, but its surprising how many times the efficiency itself is not the main driver to the choice of equipment, or that the system efficiency is set too low to have an impact on the BER, instead seen as just meeting the Building Regs.

Cooling Tab
If Cooling is part of the HVAC system then this sub requires an input level very similar to that of the heating.
The basic input is Pack Chiller type, if appropriate, Generator Type, Generator kW output and fuel type – all basic information.

If it's on the ECA list it's the same information as for heating.

There is a tick box asking if the HVAC system has mixed mode operation strategy.

The most important information, and like the heating sub tab, is usually the information that is missing from specifications or manufacturers technical information.

'Do you know the generator seasonal energy efficiency ratio' (SEER) and 'Nominal energy efficiency ration (EER)?'
The default values are again low performers, so it's important to get the accurate figures for the equipment to be used.

System Adjustments Tab
This section has four sub sections to it – the first two are concerned with Ductwork and AHU leakage if appropriate to the system to be installed. Not to be confused with ventilation and extract system to which this does not apply, unless they are one and the same. These are only highlighted as a possible entry into SBEM if the appropriate HVAC has been selected.

'Has the ductwork been leakage tested?' Either a default 'No" can be selected or there is an option to select the appropriate CEN classification.

'Does the AHU meet CEN leakage standards?' Either the default of 'No', or the appropriate CEN classification can be selected.

Both of the above do affect the BER by a significant amount depending on the selection.

The second two of the four are concerned with Fan Power and Pumps, both of which contribute to the overall Auxiliary power.

'Do you know the specific Fan Power in W/l/s?' Again the default is not good so inputting a true value will help in the final result.

'Variable Speed pump?' The default is 'No', otherwise the choice is 'LTHW only' or 'both LTHW and CHW', once selected the type of sensor in the system can be selected. These can provide significant reductions in electrical energy consumption and therefore will influence the overall BER.

With all four of the above in my experience I would say I have to go back and ask the building designers or M & E engineers to provide the above information, the impact of each of them on the final BER can be quite significant, so its important to input the as designed information, and not the default SBEM settings, and if they have not been considered in the building design at design stage they really should be in terms of the SBEM calc.

Metering Provision & System Controls sub tabs
'Is this HVAC system separately sub metered?' – Either 'YES' or 'NO'

'M & T with alarm for "out of range' values?' – Either 'YES' or 'NO'

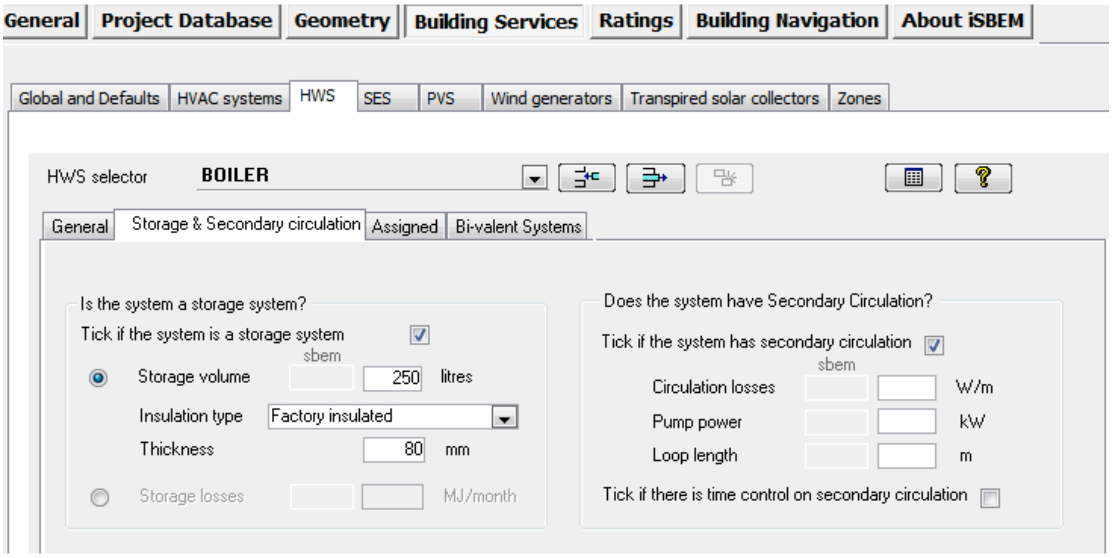
Both of the above will have a minor impact on the BER if 'YES' is selected.

'Heating System Controls' are 5 selections with a tick box if present. They do not affect the overall BER result by this selection, its purely used for the recommendations report of the EPC. However, they should marry up with any efficiency credits that have been added to the heat generator efficiency figure, these credits will improve the overall efficiency figure of the heat generator and will have an impact, if somewhat small, on the BER.

Bi-valent Systems
This sub tab is used to determine the % split in Load between different HVAC systems that serve a zone. Efficiency figures for the different systems are required here too, without which there cannot be any input.

HWS Tab
Apart from naming the system and selecting the Generator type and fuel type, the most important input is the seasonal efficiency figure, and not relying on the default figure. Am I mentioning this enough yet?

The secondary tab is for input if it's a storage system and if it has secondary circulation.



Screenshot of the Storage & Secondary Circulation sub tab within HWS

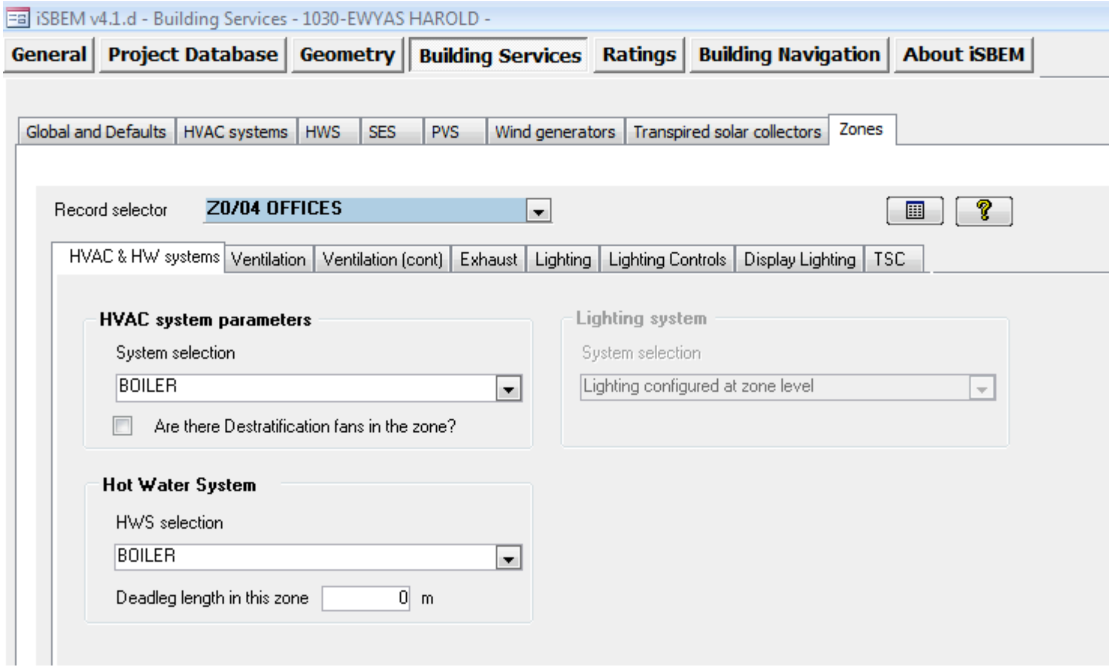
Any system that does have storage is going to be a poorer performer compared to one that does not. The input required gives a clue as to why, asking as it does either; 'Storage Losses in MJ/month Or Storage Volume', and 'Type of and Thickness of Insulation'. For new buildings Storage Losses must be entered, and again its very rare that I get this information, its much more accurate to input the actual figure rather than rely on the SBEM default, and it will effect the overall BER figure.

'Does the system have secondary circulation?'
If so there is input for Circulation Losses, Pump Power & Loop Length and a tick box for if there is a time control on secondary circulation. Again all of this information is usually not forthcoming and the default figures are not good.

To sum up the HVAC and HWS input I think I have mentioned it before but doing so again wont do any harm, system efficiencies and system losses are key figures to establish in the design of the systems and to ensure that the correct figures are input into SBEM. The default figures are generally quite poor, and the overall effect on the BER may be significant.

Zones Tab
This tab is where further information is input regarding the HVAC and Lighting systems, but rather than being global building wide input these inputs are defined at zone level. This allows for a greater degree of flexibility and allows more accuracy in the calculation, as its here that each zone can be clearly defined in the energy that it uses.

The exception to this is for DHW, SBEM assumes that every zone requires domestic hot water, so even if it's a storeroom that doesn't have any water in reality, the zone still needs to have hot water assigned to it. If there is more than one system I select the most efficient as being the default entry, and only change that if a zone has hot water and the correct system is then assigned to it. It makes little difference to the BER as all SBEM calculations apply this convention.

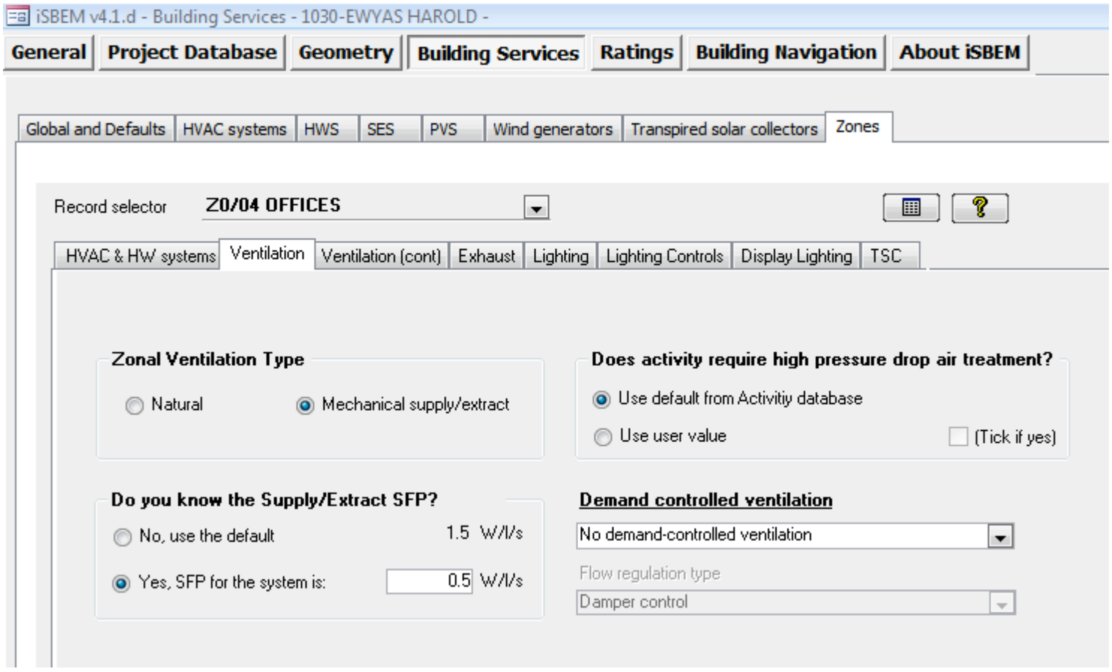


Screenshot of the Zones – HVAC & HW Systems sub tab

If more than one HVAC system is present then the appropriate one is selected for the zone, as is the HWS system as mentioned above. There is an input for dead leg lengths but I have found this makes no difference to the BER, although it must be entered.
There is also a tick box for denoting if Destratification fans are present, but again this appears to have very little impact on the BER.

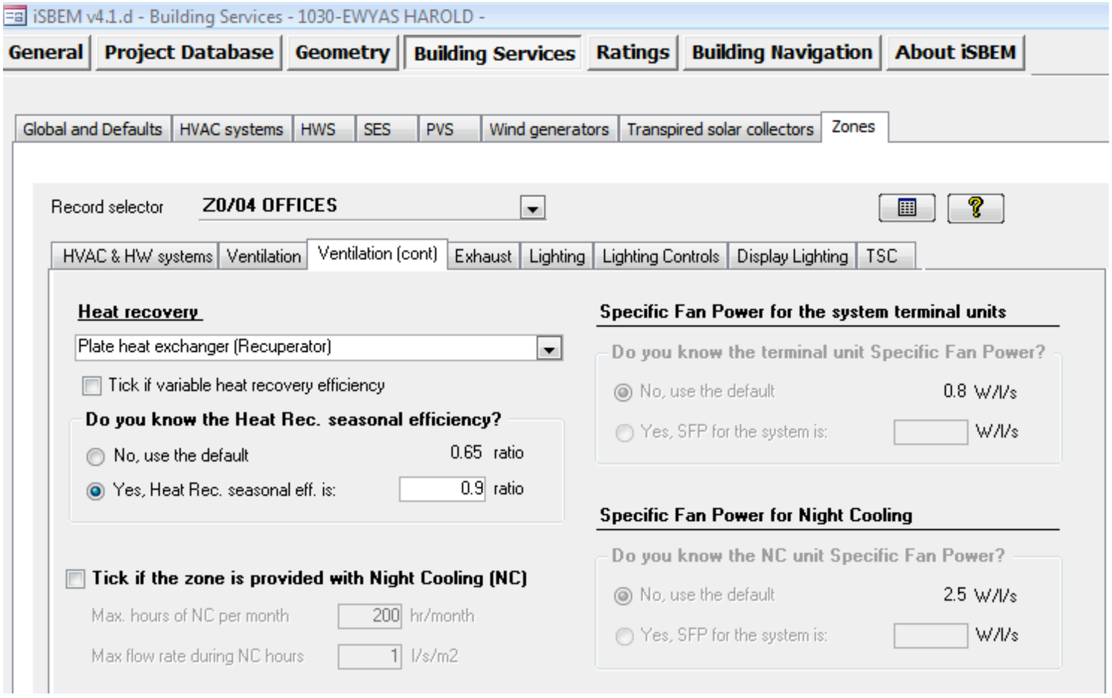
The final input is for DHW and if a dead leg is applicable to the zone. The rules are that if the zone is larger than 3m and is an activity that is likely to use a hot water supply, then dead legs lengths are entered. The actual figure is the length of the zone plus floor to ceiling height as a default.

Ventilation & Exhaust sub tabs



Screenshot of the Zones – Ventilation sub tab

If Ventilation is selected and the mechanical supply/extract is selected, the SFP in W/l/s is entered for the system. The default is 1.5, however, the Building Regs minimum for a new build is 0.4, so in reality either 0.4 or below is required. Also required is Ventilation Flow in l/s/m2. Again rarely is this information provided and instead we have to carryout a rather crude calculation to input a figure, we cannot take the default figure any longer. Therefore both of these figures are important for the overall BER, the overall results of this entry will show in the Auxiliary tab in the SBEM results.



Screenshot of the Zones – Ventilation (cont) sub tab

If Heat Recovery is present, the type of heat recovery is entered (Thermal Wheel, plate heat exchanger etc) with the Heat Recovery Seasonal Efficiency and the SFP for the terminal units as appropriate.

If 'Night Cooling' is present the maximum hours per month are entered, along with the maximum flow rate in l/s/m2 and again the SFP. Likely only to be present with more complicated air conditioning systems where true mixed mode is utilised.

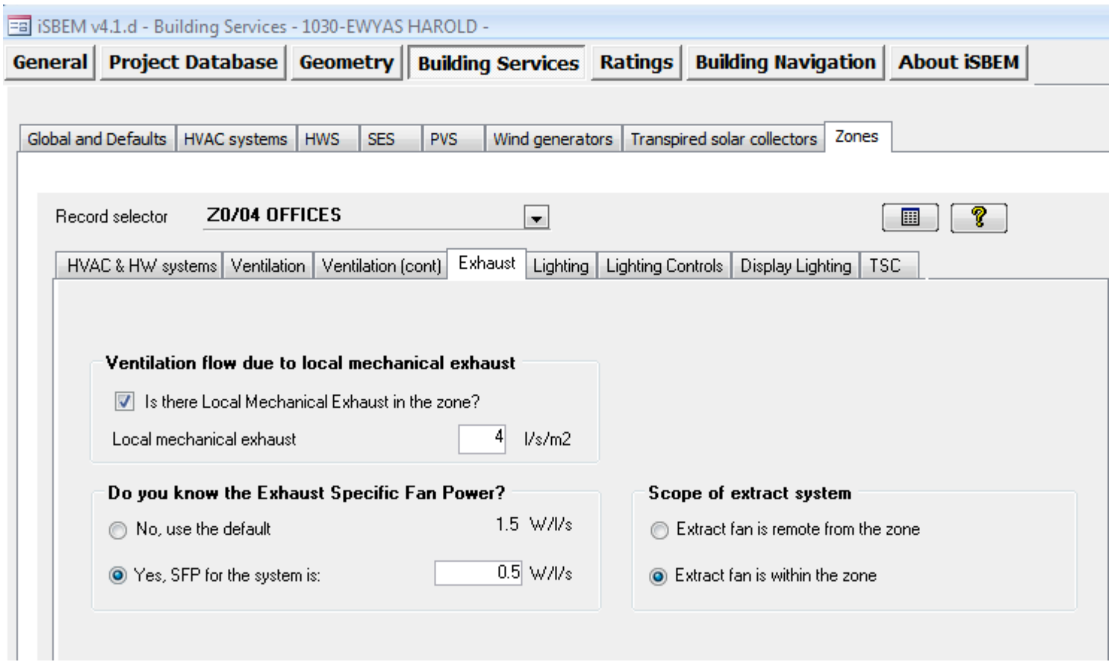
In all the above if mechanical ventilation/extract is part of the designed HVAC then its important to input the realistic design figures for the fans. Often, this is left out, again mainly for small buildings where this energy use can have a considerable impact and again, using default values will give a poor result.

Other information available to input are 'Does activity require high pressure drop air treatment?' Use default or a user value.

Demand Controlled Ventilation – if present an appropriate selection can be made along with the appropriate flow regulation type. This option is made available only when mechanical ventilation is selected.

Both of these last two above have a minimal impact on the overall result and depending on the input selection made.

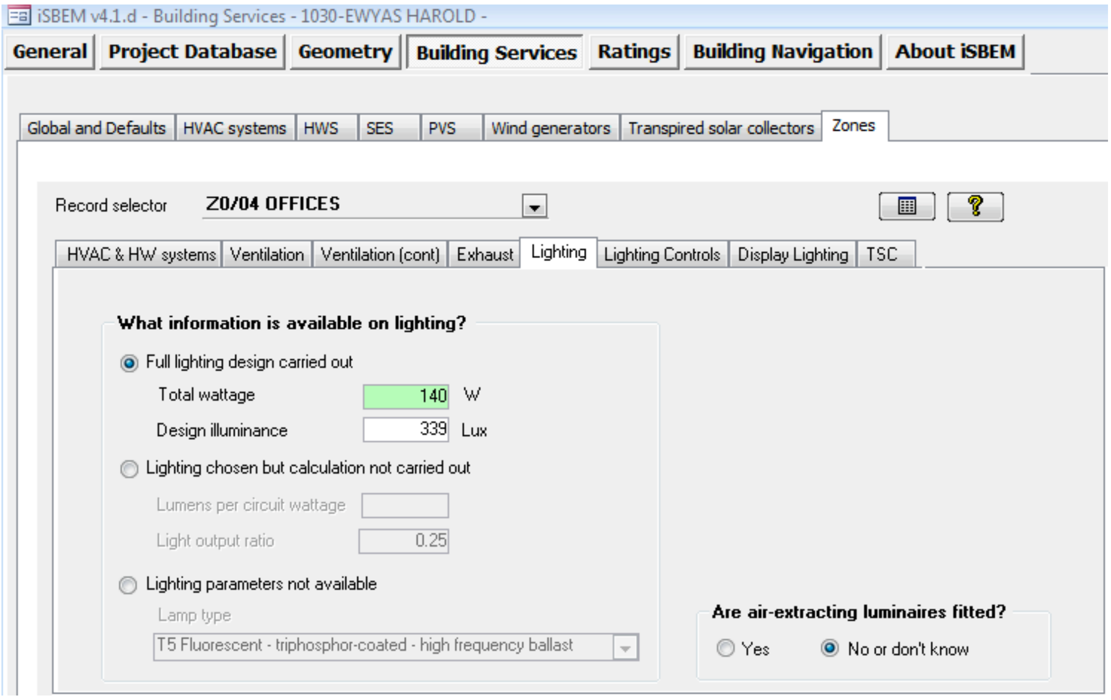
If the system is one for extraction only, there is less input to provide, but again its l/s/m2 and the SFP figures which are important.



Screenshot of the Zones – Exhaust sub tab

To sum up the mechanical ventilation/extract input – SFP in W/l/s, Heat Recovery Seasonal Efficiency Ratio, and l/s/m2 extract rate are the key figures required, all of which will impact on the BER.

Lighting, Lighting Controls & Display Lighting sub tabs



Screenshot of the Zones – Lighting sub tab

Lighting in SBEM has most probably the highest impact of all the HVAC on the BER result, and is usually the one input, which is given the least consideration in the specification, at least in most small buildings but also in some reasonably sized ones too. And if the input is available its often not the most appropriate to get the best results. Below details what the best input should be, this information should be provided on a room-by-room basis.

For each room:

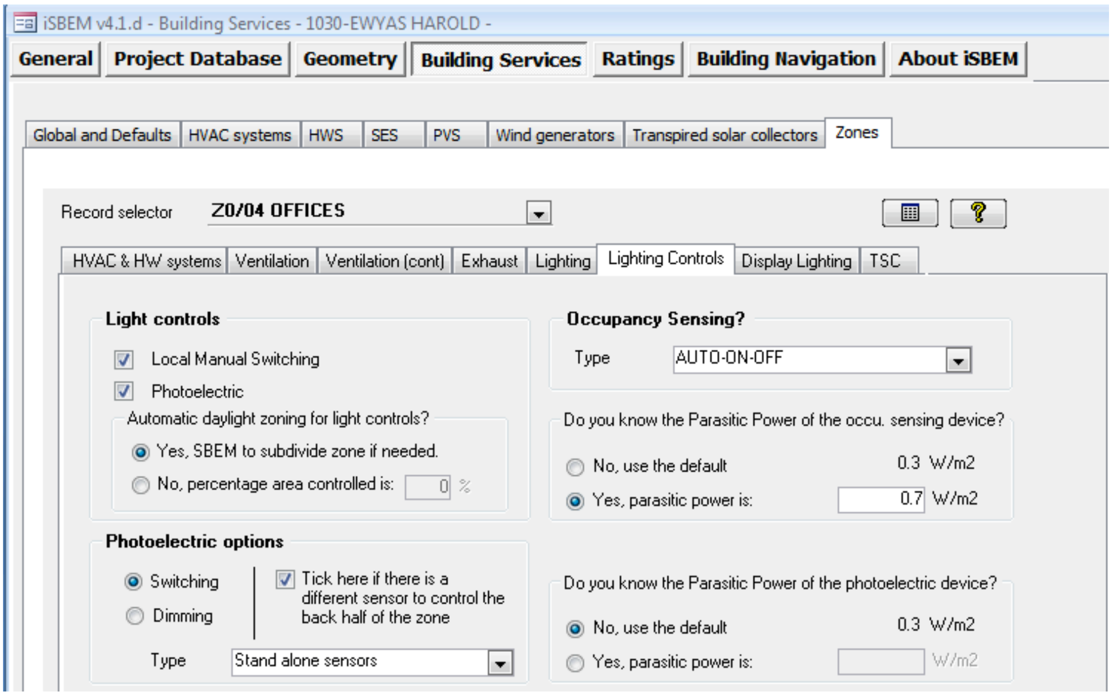
- Lamp type – ie T5, CFL, LED etc
- Total wattage of all lamps and controls in the room
- The design Lux for the room.

If two rooms are joined to form one zone, then adjustments to the watts & Lux figures are made.
If a zone contains different lighting types it can be subdivided into different zones, for example T5 and Halogen display lamps, following the rules as previously mentioned for zoning, but mixed with different envelope types and this seemingly simple room could end up very complicated indeed!

That's all that is needed for the best result, and often is the difference between a pass and fail and achieving the BER figure. Also, by inputting these figures, rather than relying on the very basic input of just the lamp type, along with appropriate lighting controls, will often bring the lighting figure alone in SBEM to be better than the Notional Building, if using just the lamp type input, the lighting figure is often double that of the Notional building.

If a full lighting design has not been carried out, there is an option to input a lumens per circuit wattage per zone, this can still achieve a good result, but rarely in my experience has it been as good as the first option above. Also required for this input is the Light Output Ratio of the Luminaire.

The very worst option is to just input the lamp type; in this SBEM assumes some very poor figures and would rarely achieve a pass on its own. As the input is at zone level, this option can be used successfully for small areas where a full lighting design is not practical or necessary, store cupboards, for example.



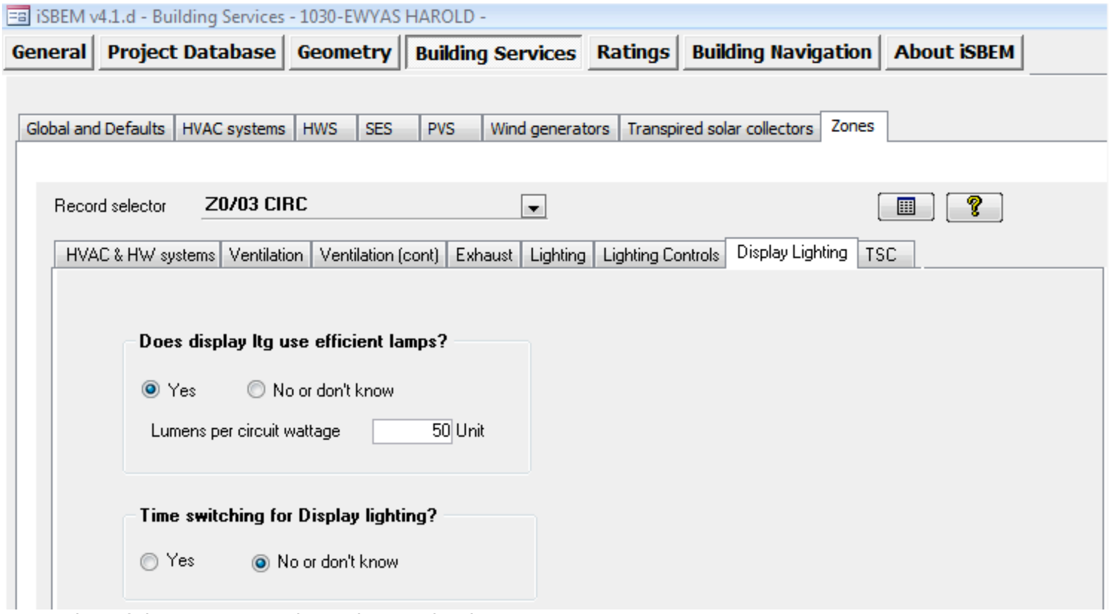
Screenshot of the Zones – Lighting Controls sub tab

Additionally the lighting controls should be entered too, otherwise SBEM assumes no occupancy controls and all manual switching.

There are many options to select from, manual switching or photoelectric or both, switching or dimming, type of sensors and the parasitic power of the devices.

The important point here is that, like the lighting itself, the controls are often disregarded in some buildings, and by designing a control package does influence the overall BER result.

The best results generally come from photoelectric controls, with addressable systems for switching, occupancy sensing as auto on/auto off, and a parasitic power figure of less than 0.3 W/m2.



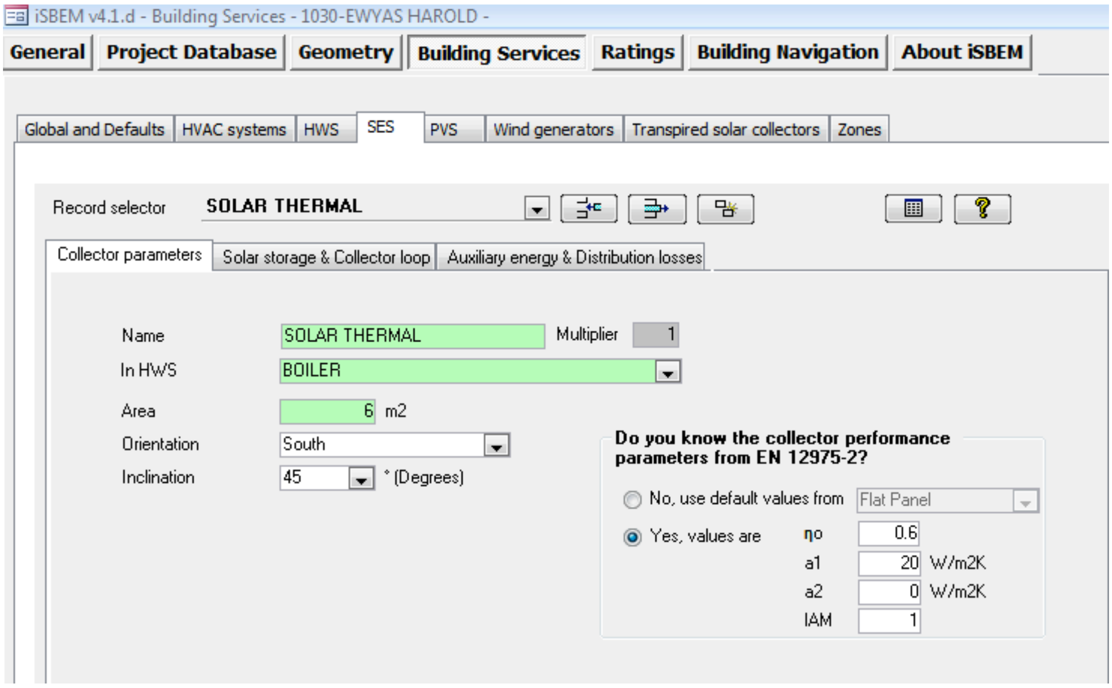
Screenshot of the Zones – Display Lighting sub tab

Finally Display Lighting, this is only activated for an input if an appropriate zone activity type is selected, i.e. Reception, Entrance, Retail Space etc. that may have display lighting present.

The input is 'Does display lighting use efficient lamps?' If yes then the Lumens per circuit wattage figure is entered, if this is unknown, and the rest of the zone uses energy efficient lamps, then a default figure of 50 must be entered.
If the display lighting is not energy efficient or unknown, then SBEM will assume tungsten lamps which will almost certainly cause a fail overall. In one calculation that I did, just two zones out of the total 50 or so were deemed to have display lighting, if they were inefficient ones the building resulted in two EPC points difference, that difference was between a pass and fail overall.
The best input therefore is if display lighting is going to be present, it should be included in the overall lighting design and the appropriate figures provided for the calculation.

Renewable Energy Tabs
There was a point where the input in these tabs was a rarity but not any longer. The weighting to renewables and the overall effect on the BER has changed so that it is not so easy to gain compliance by adding a renewable energy source to make up for under performance elsewhere. However, they do help, especially PV because of the emissions factors mentioned earlier are so high for grid electricity, so any offsetting by micro generation is going to help the overall performance and lower the CO2 emissions. The input required is fairly minimal at present but again, like the other defaults for the HVAC, its better to input the correct figures for the system to be installed than to rely on SBEM values for efficiencies etc.

Solar Hot Water sub tab
Collector Parameters



Screenshot of the SES sub tab

The main input is the Gross Area of the panels, their orientation and pitch.

Additionally the type of panel - flat plate, unglazed or evacuated tube.

The last input is instead of using default values associated with the different panel types, there is input for;

- no
- a1 W/m2K
- a2 W/m2K
- IAM

Solar storage & Collector loop
We need the Solar store volume, if a separate solar store or a combined one, and how well insulated.
'Do you know the heat transfer rate of the heat exchanger in the collector loop?'
Required is the value in W/K

And
'Do you know the overall heat loss coefficient of all pipes in the collector loop?'
Again, required is the value in W/K

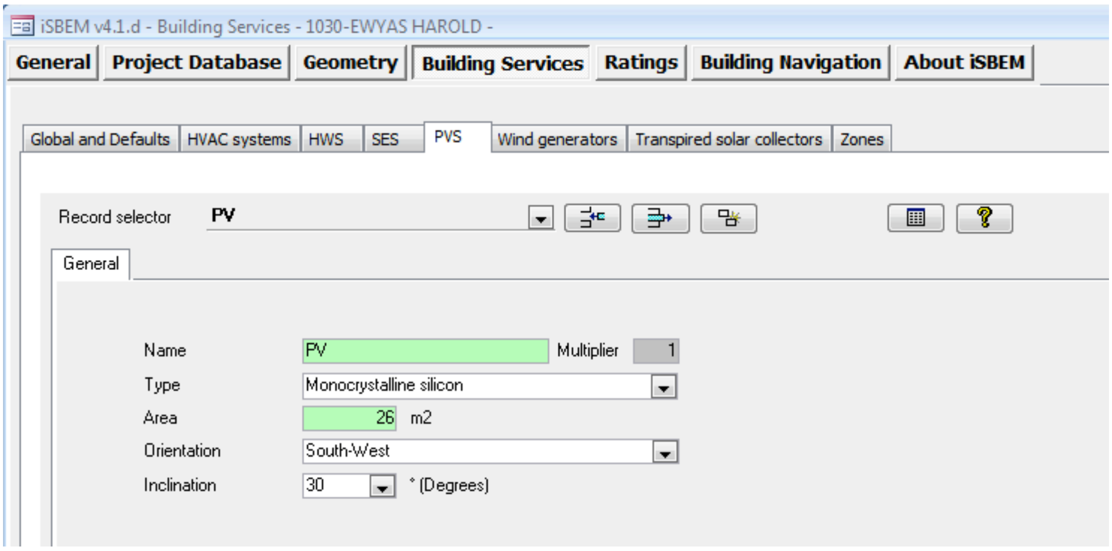
Auxiliary energy & Distribution losses
'Are the insulation pipes between the SES and the back up system insulated?' Yes or No

Auxiliary energy consumption asks for the type of system – thermosiphon system, forced circulation with or without PV.

And finally the nominal power of the pumps in W.

The effect of entering a solar hot water system is very beneficial on the overall BER, however, the type of system is important, flat plate have higher efficiencies than evacuated tubes, there is the cylinder and distribution pipes which will have heat losses and there is energy use and appropriate efficiencies for the pumps to be taken into the calculation too. Therefore although the presence of the system is beneficial, how beneficial will depend very much on the detail figures input and not to rely on the SBEM default values which is so often the case.

PV sub tab



Screenshot of the PVS sub tab

Entering PV is one of the simplest level of details that as mentioned previously can have the largest impact on the overall BER.

Type of system is required – monochrystaline, polycrystalline, amorphous or other thin films. Monochrystaline seems to be the most popular type of panel and is the most efficient of the 4 types above.

There are then entries for Area, Orientation and Pitch.

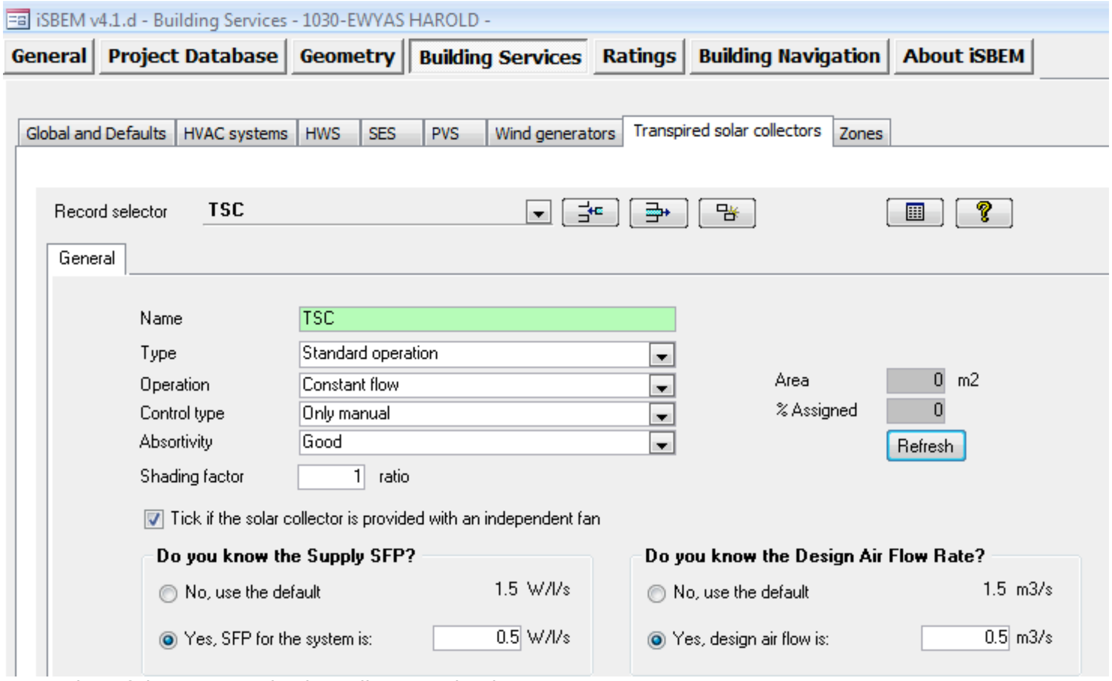
Wind sub tab
Very rarely it seems are wind systems used on buildings, although like PV their impact can be significant on the overall result.

Main input required is Terrain Type – suburban or industrial, farm land, smooth flat country or urban with average building height above 15m

Swept area – if horizontal blades the diameter is required, for others the area m2.

Finally, the height of rotor hub above ground, and the power in Kw.

Transpired Solar Collectors sub tab



Screenshot of the Transpired Solar Collectors sub tab

This is a relatively new input field and one I have yet to use on a new building. TSC's are a solar energy technology that operates by collecting incident solar radiation and transferring it to the mechanical supply of fresh air to the building, thereby reducing the heating requirement. The main component is a perforated plate absorber that is installed as an additional skin to all or part of a wall surface. The effect of TSC's on the final BER can be quite significant.
The input is again, as any other HVAC much better if system efficiencies are known.

- Type of system is entered – standard operation, high temperature rise or high air volume
- Constant or variable flow
- Manual or automatic controls
- Absorbtivity – low to very high, usually only available from the manufacturer
- Shading Factor ration
- Area m2 and % assigned are worked out automatically from the input in the Geometry tab.

There is an entry to identify, which TSC is associated with which external wall, and the area of the TSC is entered.

If there is an independent fan then the SFP W/l/s, the default is 1.5, and finally the Design air flow rate in m3/s, the default is 1.5

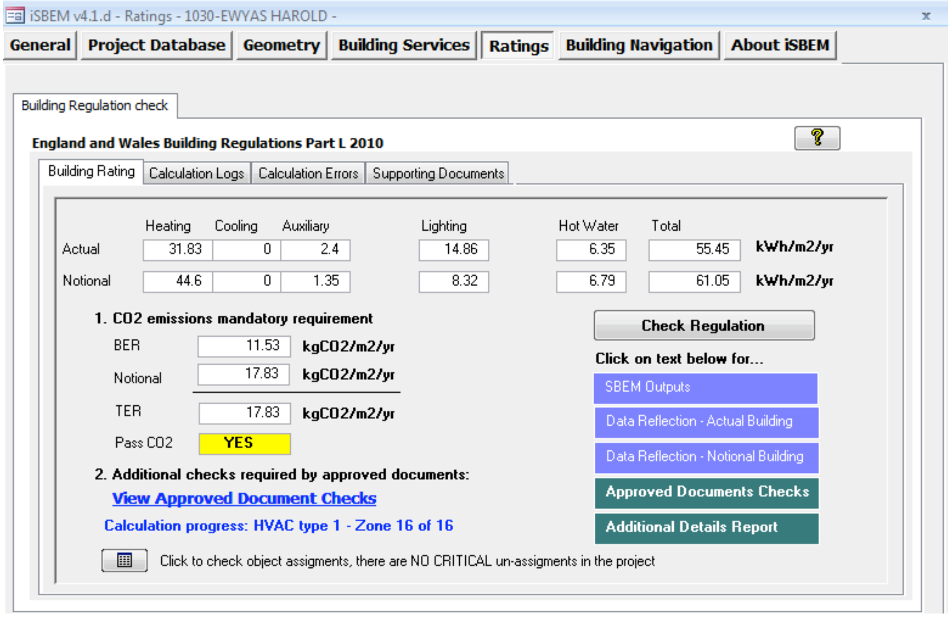
Under the Zones tab there is one final input for a Transpired solar collector, and that is to determine the % supply.

Ratings Tab

This is the final tab which shows the result of the calculation and provides downloads of the various outputs.

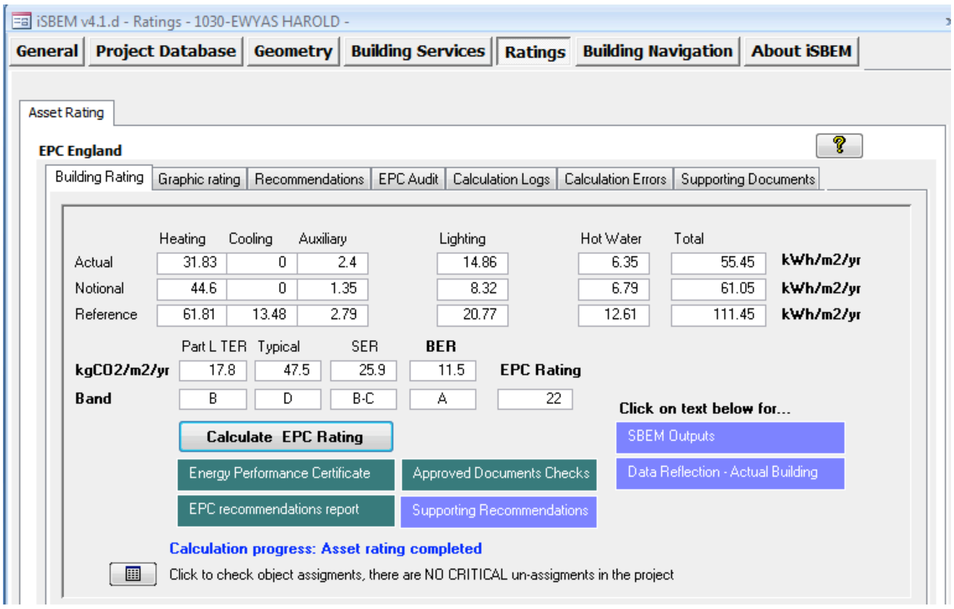
If the purpose for analysis tab was selected for Building Regulation compliance then the key figures for BER and TER are shown, together with a Approved Document Checks form which is the BRUKL Output Document (see below) used to demonstrate compliance with the 5 Criterion of Part L2A.

Also on the screen is a summary in kWh/m2/yr for each of the main HVAC systems – Heating, Cooling, Auxiliary, which includes all pumps and fans, Lighting and Hot Water. These figures compare the actual building with the Notional so that it's easy to see on a first run of the calc where improvements may need to be made.



Screenshot of the Building Rating tab if Building Regulations output has been selected

There are other tabs and downloads which are primarily for the assessor to check their work and do not require any information from the client. However, of note is the Recommendations Tab, this is where EPC recommendations are edited. The conventions for producing EPC's allow for some changes to the recommendations generated automatically by the report, however, they cannot be removed from the report unless there is some good reason that can be justified. For example if a wall was solid but the fill a cavity wall recommendation was present, it should be taken out as its totally inappropriate, but otherwise they should remain, even if its felt they may be inappropriate, like for example a wind turbine on a building within a city.



Screenshot of the Building Rating tab if EPC output has been selected

If the purposes for analysis was set to provide an EPC, the outputs are similar but as can be seen below an additional kWh/m2/yr figure is produced for the Reference building, this is the building compared to the actual to generate the EPC rating.

There are also three overall figures to which the BER is compared – Part L TER as above, a Typical building of the same type, age, construction etc, and the SER (Standard Emission Rate) which are the CO2 emissions in kgCO2/m2 adjusted by an improvement factor. Finally the EPC asset rating, A-G, which is simply the ratio of the BER and SER multiplied by 50.

Building Regulations as above can also be checked in this version of the analysis, as the EPC will be produced with the As Built SBEM.

Summary

The Key points of note from this book are the following:

Use an Approved assessor to provide your SBEM calculations and eventually the Energy Performance Certificate – look for accreditation with CIBSE, NHER, BRE, Elmhurst or others.

Ensure SBEM calculations are carried out for all projects at both Design stage, i.e. before any building work actually commences, and again upon completion. Building control will require this anyway nut its amazing how many projects 'forget' the first calculation and end up in trouble.

"What goes in is what comes out" – the quality of the input is vital to a good result, SBEM is only a calculation after all, so the more detailed information that can be input at design stage will provide the best result and if its little changed by the time the project is built, will provide the expected result at completion too.

Get to know what the minimum requirements of Part L are, but also what the minimum values are for the Notional Building are for your building type – it's these values that the project is being compared against.

The Mechanical & Electrical systems have the greatest influence on the result in SBEM, a lot more than the thermal efficiency, therefore details are necessary – system efficiencies and controls need to be determined.

Based on the above, Lighting has a huge influence, so a full lighting design with total Watts and design Lux levels, plus the lighting controls, really do have an impact on the final result, and is often the difference between a pass and fail overall.

Finally, stair details, drainage and cold water distribution may be interesting to you but for the purposes of supplying an SBEM calculation just clutter up the specification, so please remove them, and anything like them, we don't want to see them,ever…

If you have any comments or suggestions to make regarding the content of this book please contact me at info@energy-saving-experts.com.

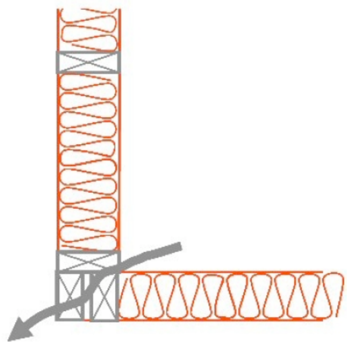
Appendix 1 -
What is Thermal Bridging?

A thermal bridge is created when materials that are poor insulators come in contact, allowing heat to flow through the path created. Insulation around a bridge is of little help in preventing heat loss or gain due to thermal bridging; the bridging has to be eliminated, rebuilt with a reduced cross-section or with materials that have better insulating properties, or with an additional insulating component (a thermal break).

Thermal bridges are categorised into three types, Repeating, Non-Repeating and Random.

Repeating Thermal Bridges
A common repeating thermal bridge is where a layer of insulation in a cavity wall is bridged by timber studs. As this occurs regularly throughout the element, ie the wall, this is deemed a repeating bridge and must be accounted for in the U Value calculation for the element by making the appropriate corrections.

Non-Repeating Thermal Bridges
A non-repeating thermal bridges would be where the ground floor and external wall joins, a common bridge here is where the insulation in the wall and the floor do not join, forming a cold bridge at the corner. This type of thermal bridge needs to be accounted for in any SBEM calculation as the combined heat loss from non-repeating thermal bridges over an entire building can account for up to 15% of the total. If the building thermal envelopes have very low U Values and the junctions between each are not accounted for in the design details, the percentage of heat loss through the non-repeating bridges increases.



The visual effect of cold bridging is condensation forming in the corners of rooms, and mould growing in due course. This is particularly a problem where corners are exposed externally to the cold, i.e. predominantly in shade or if internally corners are hidden by wardrobes and other furniture and little movement of warm air circulates nearby.

Random Thermal Bridging
Random bridging is where there is a one off bridge, for example a steel beam in a wall construction. These are dealt with in SAP by applying a procedure to account for it in the U Value calculation as detailed in BR443. However, good building practice would dictate that this type of bridge be minimised as much as possible.

This paper is concerned with Non-Repeating Thermal Bridges only.

How are Thermal Bridges accounted for in SBEM?
Ψ values
The Ψ value is a measurement of heat loss, in Watts/meter Kelvin (W/m.K) across a given junction between the external wall and another element.

When multiplied by the length of that junction this becomes the linear thermal transmittance, or y value. All of the different y values are added together to provide the one figure that is then divided by the heat loss areas and used in the SBEM calculation.

This can be expressed as follows:

- Junction length (m) x Ψ value = y value
- Sum y values / Sum area of heat loss envelopes (A heat loss floor+ A heat loss walls + A heat loss roof) = total y value.

Appendix 2 – BRUKL Document

BRUKL Output Document

HM Government

Compliance with England and Wales Building Regulations Part L 2010

Project name

[redacted] As built

Date: Sat Apr 07 15:38:08 2012

Administrative information

Building [redacted]

Owner [redacted]

Certification tool

Calculation engine: SBEM

Calculation engine version: v4.1.d.0

Interface to calculation engine: iSBEM

Interface to calculation engine version: v4.1.d

BRUKL compliance check version: v4.1.d.0

Certifier details

Name: Michael Andrews

Telephone number: 01225 862266

Address: 3 Fieldins, Winsley, Bradford on Avon, BA15 2JU

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

1.1	CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	17.8
1.2	Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	17.8
1.3	Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	11.5
1.4	Are emissions from the building less than or equal to the target?	BER =< TER
1.5	Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

2.a Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.35	0.48	z0/03 ne
Floor	0.25	0.12	0.13	Z0/01 WC BLOCK/f
Roof	0.25	0.13	0.13	Z0/03 CIRC/c
Windows***, roof windows, and rooflights	2.2	1.8	1.8	Z0/04 OFFICES/se/g
Personnel doors	2.2	0.81	0.81	PD
Vehicle access & similar large doors	1.5	-	-	"No heat loss vehicle access doors"
High usage entrance doors	3.5	-	-	"No heat loss high usage entrance doors"

$U_{a-Limit}$ = Limiting area-weighted average U-values [$W/(m^2K)$]
U_{a-Calc} = Calculated area-weighted average U-values [$W/(m^2K)$]
U_{i-Calc} = Calculated maximum individual element U-values [$W/(m^2K)$]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	10

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2.b Building services

The building services parameters listed below are expected to be checked by the BCO against guidance. No automatic checking is performed by the tool.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	NO
Whole building electric power factor achieved by power factor correction	<0.9

1- BOILER

Heating seasonal efficiency	Cooling nominal efficiency	SFP [W/(l/s)]	HR seasonal efficiency
0.94	-	-	-
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system			NO

2- ELECTRIC TUBE HEATERS

Heating seasonal efficiency	Cooling nominal efficiency	SFP [W/(l/s)]	HR seasonal efficiency
1	-	-	-
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system			NO

1- BOILER

Heating seasonal efficiency	Hot water storage loss factor [kWh/litre per day]
Hot water provided by HVAC system	-

Local mechanical ventilation and exhaust

Zone	Supply/extract SFP [W/(l/s)]	HR seasonal efficiency	Exhaust SFP [W/(l/s)]
Z0/05 STORE	-	-	0.4
Z0/01 WC BLOCK	-	-	0.4
Z0/02 SERVERY	-	-	0.4

General lighting and display lighting

Zone	General lighting [W]	Display lamps efficacy [lm/W]
Z0/08 STORES	30	-
Z0/03 CIRC	140	-
Z0/04 OFFICES	140	-
Z0/05 STORE	70	-
Z0/06 PARADE ROOM	420	-
Z0/07 LECTURE 2	140	-
Z0/09 LECTURE 1	140	-
Z0/10 LECTURE 3	420	-
Z0/01 WC BLOCK	90	-
Z0/02 SERVERY	70	-

Criterion 3: The spaces in the building should have propriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Z0/04 OFFICES	NO (-80.6%)	NO
Z0/06 PARADE ROOM	NO (-69.7%)	NO
Z0/07 LECTURE 2	NO (-72.1%)	NO
Z0/09 LECTURE 1	NO (-72.5%)	NO
Z0/10 LECTURE 3	NO (-87.5%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	190.7	190.7
External area [m²]	566.6	566.6
Weather	BIR	BIR
Infiltration [m³/hm²@ 50Pa]	10	5
Average conductance [W/K]	133.31	217.42
Average U-value [W/m²K]	0.24	0.38
Alpha value* [%]	16.3	35.29

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
	C2 Residential Inst.: Universities and colleges
	C2A Secure Residential Inst.
	Residential spaces
61	**D1 Non-residential Inst.: Community/Day Centre**
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
39	**D1 Non-residential Inst.: Education**
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Telephone exchanges
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	31.83	44.6
Cooling	0	0
Auxiliary	2.4	1.35
Lighting	14.86	8.32
Hot water	6.35	6.79
Equipment*	13.01	12.68
TOTAL	55.45	61.05

* Energy used by equipment does not count towards the total for calculating emissions.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	14.47	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Indicative Target
Heating + cooling demand [MJ/m²]	132.25	177.07
Total consumption [kWh/m²]	55.45	61.05
Total emissions [kg/m²]	11.5	17.8

HVAC Systems Performance										
System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] No Heating or Cooling										
	Actual	0	2.3	0	0	0	0	0	0	0
	Notional	0	0.5	0	0	0	0	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] LPG, [CFT] Electricity										
	Actual	96	34.2	31.8	0	2.4	0.84	0	0.94	0
	Notional	129.6	44.4	44.6	0	1.2	0.79 / 0.81	0	----	----
[ST] Other local room heater - unfanned, [HS] Room heater, [HFT] Electricity, [CFT] Electricity										
	Actual	124.5	76.2	43.2	0	3.8	0.8	0	1	0
	Notional	170.3	102.7	59.7	0	3.7	0.79 / 0.81	0	----	----

Key to terms

Heat dem [MJ/m2] = Heating energy demand
Cool dem [MJ/m2] = Cooling energy demand
Heat con [kWh/m2] = Heating energy consumption
Cool con [kWh/m2] = Cooling energy consumption
Aux con [kWh/m2] = Auxiliary energy consumption
Heat SSEFF = Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER = Cooling system seasonal energy efficiency ratio
Heat gen SSEFF = Heating generator seasonal efficiency
Cool gen SSEER = Cooling generator seasonal energy efficiency ratio
ST = System type
HS = Heat source
HFT = Heating fuel type
CFT = Cooling fuel type

Appendix 3 - Energy Performance Certificate (EPC)

Energy Performance Certificate
Non-Domestic Building

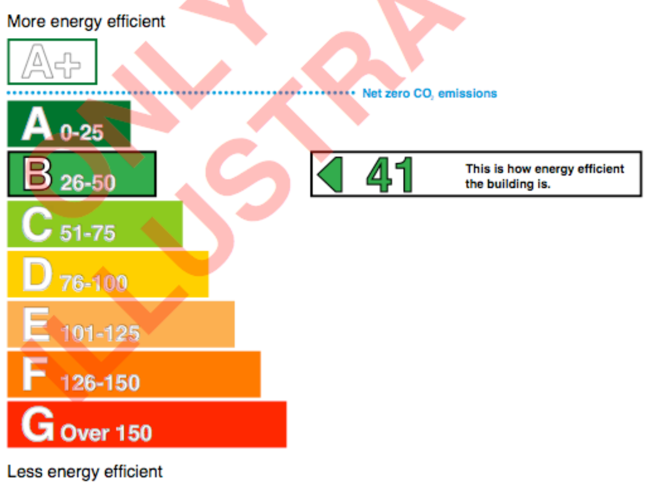
HM Government

[redacted]

Certificate Reference Number:
9780-3002-0920-0305-0425

This certificate shows the energy rating of this building. It indicates the energy efficiency of the building fabric and the heating, ventilation, cooling and lighting systems. The rating is compared to two benchmarks for this type of building: one appropriate for new buildings and one appropriate for existing buildings. There is more advice on how to interpret this information on the Government's website www.communities.gov.uk/epbd.

Energy Performance Asset Rating



Technical Information

Main heating fuel: Natural Gas
Building environment: Heating and Natural Ventilation
Total useful floor area (m^2): 2574
Building complexity (NOS level): 4
Building emission rate ($kgCO_2/m^2$): 39.42

Benchmarks

Buildings similar to this one could have ratings as follows:

32 If newly built
86 If typical of the existing stock