National Calculation Methodology (NCM) modelling guide for buildings in Gibraltar

2024 Edition

October 2024

Main Changes in this Edition

The main changes in the technical requirements of the software since the issue of the previous Gibraltar NCM Modelling Guide are as follows:

1. Additional provisions for approved DSM software tools.

CONTENTS

INTRODUCTION

1. This document, which takes effect from October 2024 onwards, gives guidance on the operation and use of the Government of Gibraltar's version of the Simplified Building Energy Model (SBEMgi), and other approved software tools, comprising the National Calculation Methodology (NCM) for Gibraltar, when:

   a. Demonstrating compliance with the primary energy requirements of the Building Rules Part F[1] for Gibraltar.
   b. Calculating asset ratings when preparing Energy Performance Certificates (EPCs).

2. This document is under continuous review and will be updated as and when the need for additional clarification is identified. This regular updating will help improve the consistency of application of the software tool to the Building Rules compliance and energy certification processes.

Approved software

3. To be approved for calculating the energy performance of buildings, for the purposes of assessing compliance with the Gibraltar Building Rules and calculating the ratings for the EPC, the software tool has to demonstrate that:

   a. the calculations are technically robust, and that they cover a necessary minimum set of energy flows.
   b. it follows the procedures for compliance and certification as defined in this document, including the use of the NCM Databases, the definition of the Reference building, and the calculation of the compliance target.
   c. it reports a minimum set of output parameters, and that these parameters can be passed appropriately to standard modules for:
      i. Compliance checking
      ii. Producing an EPC and deriving a set of recommendations for energy efficiency improvements.

4. Approved Dynamic Simulation Model (DSM) software must automatically generate the Reference building from information provided by the user for the Actual building.

5. DSM software must meet or exceed the classification of dynamic modelling under CIBSE AM11.

6. All software is expected to be developed in accordance with ISO 90003:2004 – 'Guidelines for the application of ISO 9001:2000 to computer software'.

Version policy

[1] Building Rules Part F 2017

7. All software tools, including SBEMgi and approved DSMs, evolve with time as improvements are made to functionality and the quality of the underlying algorithms. This means that it is necessary to have in place a procedure whereby new versions can be accepted as appropriate for use within the compliance/certification process. The following rules define the procedures approved by the Minister for the Environment & Tourism:

8. For certifying compliance with Building Rules:

a. The earliest version of the software tool (i.e., software and NCM databases) that can be used in any initial notification is the latest approved version available 6 months prior to application to Building Control.
b. Developers can subsequently elect at various key points in the process the version of the tool that they will use for compliance and certification purposes. These key points are:
    i. Primary energy calculation before commencement of work, and
    ii. Primary energy calculation after completion.
c. At either (or both) of these stages, developers can elect to adopt a more recently approved version of the tool, but having elected to use a later version, developers cannot subsequently revert to using a previous one.

9. For producing EPCs, the most recently approved version of the software tool should be used, unless the latest version has been released less than one calendar month prior to the assessment date. In such cases, the immediately previous version of the tool may be used. For newly constructed buildings, the version used to demonstrate compliance with Building Rules may also be used to produce the EPC.

10. To facilitate this process, each new version will be backwards compatible with all previous versions, i.e., it can either read the data files of previous versions, or a file conversion utility will be provided.

Choosing a software tool

11. All calculation methods involve a degree of simplification, and two classes of software tool are available for use for Building Rules compliance or EPC generation for both dwellings and buildings other than dwellings in Gibraltar:

a. SBEMgi, the Simplified Building Energy Model for Gibraltar developed by HM Government of Gibraltar (Department of the Environment, Heritage, and Climate Change). This can be applied to any building (irrespective of size) although there are some cases, as described in paragraphs 13 to 16, where representation of certain building features will require some approximation.
b. Approved Dynamic Simulation Models (DSMs). These will be applicable for any building unless an individual DSM's approval specifically excludes certain classes of building or building features. They may prove more flexible than SBEMgi in handling certain building features and are also more suited as design support tools (as opposed to carrying out compliance and certification calculations).

12. Software interfaces to SBEMgi must also be approved before the overall software tool can be used. *Interface approval as well as software approval is necessary to ensure that procedures are followed appropriately as well as the calculations being carried out correctly.*

SBEMgi constraints

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

14. Examples of building features where such issues can arise include:

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

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

16. It is recommended that users make full use of features such as, the ‘multiplier’ function in SBEMgi and merging of all contiguous similar areas (see paragraph 112), in order to generally avoid creating more zones than necessary, enhance clarity of the models, and help with quality audits. The default version of the SBEMgi engine runs on 64-bit Windows operating systems, i.e., it will not run on computers with 32-bit Windows operating systems. However, there is an optional 32-bit version of the SBEMgi engine which can be used on computers running 32-bit Windows operating systems. NB: Memory limitations might affect the maximum number of zones/objects which can be modelled on 32-bit Windows operating systems.

COMPLIANCE WITH BUILDING RULES

17. This section of the guide defines the basis for setting the Target Energy Rate (TER). Rule F3 requires that all new buildings must achieve or better this target. The TER is based on the performance of the Reference building (see below), and the following procedure must be followed in order to establish the TER. The procedure converts calculated building loads into delivered energy requirements (and hence primary energy consumption) using seasonal efficiency parameters. *This approach is adopted to avoid the need to define system models appropriate to each type of building. It also ensures a consistent approach to the target setting process.*

18. Compliance with Building Rules Part F is by reference to a Target Energy Rate (TER). This is calculated by applying a) an Improvement Factor and b) a Renewable Factor to the performance of the Reference building – the Reference Energy Rate (RER) expressed in terms of primary energy consumption, in kWh_{PE} per m^2 per year.

19. The value of these two factors is determined by whether the building is a dwelling or not and whether it is a stand-alone new building or an extension to an existing building (see **Table 1**).

20. The definition of the Reference building (see next section) remains unchanged from previous versions of the Building Rules, except that the fuel for heating and hot water is assumed to be grid-electricity rather than LPG.

21. A new compliance report is generated by the standard compliance software module, showing the value of the Building Energy Rate (BER), expressed in terms of primary energy consumption, in kWh_{PE} per m^2 per year, as compared with the TER (along with a number of other compliance parameters).

22. The TER is calculated by applying two improvement factors to the RER as follows:

Equation 1
$$\boldsymbol{TER = RER \times (1.0 - IF) \times (1.0 - RF)}$$

where:

*$\boldsymbol{IF}$ = Improvement Factor and $\boldsymbol{RF}$ = Renewable Factor, as per **Table 1** below:*

Table 1 Improvement factors

Building type	$\boldsymbol{IF}$	$\boldsymbol{RF}$
New dwelling	0.2	0.05
Extension to existing dwelling	0.1	0.05
New non-dwelling	0.2	0.1
Extension to existing non-dwelling	0.1	0.1

THE REFERENCE BUILDING

23. This section of the guide defines the Reference building, which is the basis for both setting the energy rating scale for Energy Performance Certificates (EPCs) and calculating the TER as described above. It does this by specifying how the calculation software is to be configured so as to carry out the modelling correctly, recognising that the individual software user will have no control over how this is done.

24. The Asset Rating rates the primary energy consumption from the Actual building in comparison to a Reference Energy Rate (RER), in kWh_{PE}/m^2, which is the primary energy consumption of the Reference Building, defined below.

25. EPCs are intended to send market signals about the relative performance of comparable buildings. In order to provide this consistency, the Reference building must be the same irrespective of:

a. Whether the Actual building is naturally-ventilated or air-conditioned[2].
b. The fuel choice in the Actual building.

26. The Reference building must have the same size, shape, and zoning arrangements as the Actual building, with the same conventions relating to the measurement of dimensions.

27. Each space must contain the same activity (and, therefore, the same activity parameter values) as proposed for the equivalent space in the Actual building. The activity in each space must be selected from the list of activities as defined in the NCM Activity Database (see paragraph 98).

28. The Reference building must be given the same orientation and be exposed to the same weather data as the Actual building. For DSM software, the Reference building must be subject to the same site shading from adjacent buildings and other topographical features as are applied to the model of the Actual building.

Building fabric

29. The U-values in the Reference building must be as specified in **Table 2**. All U-values must be calculated following the guidance in BR443[3]. The general guidance beginning at paragraph 103 must be followed.

[2] Spaces in the Reference building are all naturally-ventilated.

[3] BR 443: Conventions for U-value calculations, BRE, 2019 Edition.

Table 2 Construction elements U-value and thermal capacity for the Reference building		
Element	**U-value (W/m²K)**	**Thermal capacity[4] (kJ/m²K)**
Roofs[5] (irrespective of pitch)	0.6	12.0
Exposed walls	1.2	11.7
Exposed and ground floors (subject to paragraph 32)	0.6	36.0
Windows, roof windows, roof-lights*, glazed doors, and curtain walling	2.20	-
Display windows	5.7	-
External pedestrian doors	2.20	-
Vehicle access and similar large doors	1.50	-
Internal walls	1.2	11.7
Internal floors/ceilings	0.6	36.0

*This is the overall U-value including the frame and edge effects, and it relates to the performance of the unit in the vertical plane so, for roof-lights, it must be adjusted for the slope of the roof (BR443). The roof-lights in the Reference building are assumed to be conical or domed, and hence, for the purposes of heat transfer calculations, their developed to projected ratio is set to 1.3 (as opposed to 1.0 for flat ones), i.e., the area of the roof-light is 1.3 times the area of the opening in the roof, and its U-value adjustment is taken as +0.3 W/m²K if the roof is flat and +0.2 W/m²K if the roof is pitched.

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

31. For SBEMgi and DSM software, the non-repeating thermal bridge heat losses for each element (including windows, etc.) in the Reference building must be allowed for by adding 10% to the standard U-values. Note that the U-values as given in **Table 2** DO NOT include this allowance, and so the calculation tool must make the adjustment explicitly.

32. Special considerations apply to ground floors, where the U-value is a function of the perimeter/area ratio. The following adjustments must be made[6]:

a. If the calculated value is greater than the U-value in **Table 2**, the U-value in **Table 2** must be used in the Reference building.
b. If the calculated value is lower than the U-value in **Table 2** with no added insulation, this lower value must be used in the Reference building.

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

[4] Thermal capacity calculation in EN ISO 13790:2004

[5] Any part of a roof having a pitch greater or equal to 70º is considered as a wall.

[6] This follows the guidance given in CIBSE Guide A (2021).

34. The thermal capacity of the construction elements must be as defined in **Table 2**.

35. The air permeability of the Reference building must be 10 m^3/h per m^2 of envelope area at 50 Pa. The calculation method used to predict the infiltration rate must use the air permeability as the parameter defining the envelope leakage. For compliance and certification, the same method must be used in the Actual and Reference buildings. Acceptable methods include:

a. The method specified in the SBEMgi Technical Manual[7], which is taken from EN 15242[8].

b. Other methods that use a relationship between infiltration rate and air permeability and are set out in national or international standards or recognised UK/Gibraltar professional guidance documents which relate average infiltration rate to envelope permeability. An example of the latter would be tables 4.16 to 4.23 of CIBSE Guide A (2021).

36. In SBEMgi, the total solar energy transmittance (BS EN 410 g-value) and the light transmittance of glazing must be as given in **Table 3**. This data applies to windows, roof windows, and roof-lights. Appropriate values for intermediate orientations can be based on linear interpolation.

Table 3 Solar and light transmittances for glazing in the Reference building

Orientation of glazing	Solar transmittance	Light transmittance	Reference glazing type
North, North-East, South, North-West	0.72	0.76	1
East, South-East, South-West, West	0.58	0.61	2
Horizontal	0.43	0.46	3
Display windows facing North, North-East, South, North-West	0.72	0	-
Display windows facing East, South-East, South-West, West	0.58	0	-

37. DSMs are required to use the glass data provided in **Table 4** to **Table 6** to determine the EN ISO 410 g-value. T_{solar} is the direct solar transmittance, $T_{visible}$ is the direct visible light transmittance, R_{solar} is the solar reflectance, $R_{visible}$ is the visible light reflectance. The subscripts 1 and 2 refer to the outer and inner surfaces of each pane of glass respectively.

[7] SBEMgi Technical Manual is available at https://www.epc.gov.gi/GIEpc/100/

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

Table 4 Glass properties for Reference glazing type 1

	Thickness	T_{solar}	R_{solar1}	R_{solar2}	$T_{visible}$	$R_{visible1}$	$R_{visible2}$	$Emissivity_1$	$Emissivity_2$
Outer pane	6mm	0.821	0.074	0.074	0.913	0.082	0.082	0.837	0.837
Cavity	12mm	Argon gas fill							
Inner pane	6mm	0.664	0.111	0.092	0.822	0.109	0.098	0.170	0.837

Table 5 Glass properties for Reference glazing type 2

	Thickness	T_{solar}	R_{solar1}	R_{solar2}	$T_{visible}$	$R_{visible1}$	$R_{visible2}$	$Emissivity_1$	$Emissivity_2$
Outer pane	6mm	0.655	0.068	0.068	0.735	0.079	0.079	0.837	0.837
Cavity	12mm	Argon gas fill							
Inner pane	6mm	0.664	0.111	0.092	0.822	0.109	0.098	0.170	0.837

Table 6 Glass properties for Reference glazing type 3

	Thickness	T_{solar}	R_{solar1}	R_{solar2}	$T_{visible}$	$R_{visible1}$	$R_{visible2}$	$Emissivity_1$	$Emissivity_2$
Outer pane	6mm	0.437	0.052	0.055	0.551	0.060	0.063	0.837	0.837
Cavity	12mm	Argon gas fill							
Inner pane	6mm	0.664	0.111	0.092	0.822	0.109	0.098	0.170	0.837

Areas of windows, doors, and roof-lights

38. The areas of windows, doors, and roof-lights in the Reference building must be determined as set out in the following sub-paragraphs and must also conform to the measurement conventions set out in the guidance in **Table 14**.

a. Subject to the following criteria, all external walls must have windows, and all roofs must have roof-lights.
b. Copy the areas of pedestrian doors, vehicle access doors, and display windows that exist in the corresponding element of the Actual building.
c. If the total area of these elements is less than the appropriate allowance from **Table 7,** the balance must be made up of windows or roof-lights as appropriate.
d. If the total area of the copied elements exceeds the allowance from **Table 7**, the copied areas must be retained but no windows or roof-lights added.
e. The areas as defined in **Table 7** represent the areas of openings in the wall or roof and comprise the area of the glass plus frame. The windows, including display windows, must have a frame factor of 10% (i.e., 90% of the area of the opening is glazed) and roof-lights a frame factor of 30%.

Table 7 Percentage opening areas in the Reference building		
Building type[9]	**Windows**[10] **(of exposed wall area)**	**Roof-lights (of exposed roof area)**
Residential buildings (where people temporarily or permanently reside)	30%	0%
Places of assembly, offices and shops	40%	20%
Industrial and storage buildings	15%	20%

39. In addition, the following rules apply:

a. The Reference building does not have any high usage entrance doors, even if these are present in the Actual building.
b. In the Reference building, pedestrian and vehicle access doors must be taken as being opaque (i.e., with zero glazing).
c. No glazed area should be included in basements. In semi-basements (i.e., where the wall of the basement space is mainly below ground level but part is above ground), the **Table 7** percentages must apply to the above-ground part, with zero glazing for the below ground part.

HVAC and HW systems

40. The system performance definitions follow the practice set out in EN 15243[11]:

d. Auxiliary energy is the energy used by controls, pumps, and fans associated with the HVAC systems. It is the term described as "fans, pumps, controls" in Energy Consumption Guides such as ECG019[12].
e. The Seasonal System Coefficient of Performance (SCoP) for heating is the ratio of the sum of the heating consumption of all spaces served by a system to the energy content of the fuels (or electricity) supplied to the boiler or other heat generator of the system. The SCoP includes generator (e.g., boiler) efficiency, heat losses in pipework, and duct leakage. It does not include energy used by fans and pumps (but does include the proportion of that energy which reappears as heat within the system). For DSMs, the ventilation supplied to the zone must be taken as the outdoor air temperature. For SBEMgi, adjusted monthly average figures should be used, as specified in the SBEMgi Technical Manual[7]. Heating energy consumption is, therefore, calculated from the following expression:

[9] Determined for each activity by the NCM Activity Database.

[10] Minus areas of doors and display windows if % has not already been reached or exceeded

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

[12] Energy use in offices, Energy Consumption Guide 19, Action Energy, 2003

Equation 2 $$Heating\ energy\ consumption = Zones\ annual\ heating\ load\ /\ SCoP$$

f. The Seasonal System Energy Efficiency Ratio for cooling (SSEER) is the ratio of the sum of the sensible cooling consumption of all spaces served by a system to the energy content of the electricity (or fuel) supplied to the chillers or other cold generator of the system. The SSEER includes, inter alia, chiller efficiency, heat gains to pipework and ductwork, duct leakage, and removal of latent energy (whether intentional or not). It does not include energy used by fans and pumps (but does include the proportion of that energy which reappears as heat within the system). Electricity used by heat rejection equipment associated with chillers is accounted for in the SSEER (not as auxiliary energy). Electricity used within room air conditioners for fan operation is also included in the SSEER value since it is included in the standard measurement procedure for their EER. Electricity used by fossil-fuelled equipment and its ancillaries, including fans in unit heaters and gas boosters, is included in the auxiliary energy. For DSMs, the ventilation supplied to the zone must be taken as the outdoor air temperature. For SBEMgi, adjusted monthly average figures should be used, as specified in the SBEMgi Technical Manual[7]. Cooling energy consumption is, therefore, calculated from the following expression:

Equation 3 $$Cooling\ energy\ consumption = Zones\ annual\ cooling\ load\ /\ SSEER$$

41. For the purposes of heating, cooling, and auxiliary energy calculations, the ventilation should operate on a flat profile that is on during the occupied period only, (*i.e., each hour when the NCM daily schedule for occupancy is greater than zero*). The flow rate is determined by the product of the peak occupancy density and fresh air rate per person (both from the NCM Activity Database). The profile is the same for both natural and mechanical ventilation and does not modulate with the occupancy profile.

42. The space heating and hot water service in the Reference building is always met by grid-supplied electricity irrespective of whether a different fuel is used in the Actual building.

43. The cooling and auxiliary energy in the Reference building are powered by grid-supplied electricity.

44. The Reference building has a fixed servicing strategy regardless of the strategy adopted in the Actual building (see paragraph 123). Therefore:

a. Each space is heated, as defined by the heating set-points defined in the NCM Activity Database, and naturally-ventilated.
b. The space heating seasonal SCoP is 0.9 (i.e., accounting for distribution losses of 10%).
c. The auxiliary energy is the product of 0.61 W/m² and the annual hours of operation of the heating system from the NCM Activity Database (*i.e., the hours when the heating set-point is above the set-back temperature based on the daily/weekly/annual schedules or the "SYS_HEAT_T_HOURS_#"*[13] *fields from the "activity_sbem_D1_ACU" table in the NCM Activity Database*).

[13] "SYS_ T_HOURS_#" if the system provides both heating and cooling.

d. Each space is cooled, based on the operating schedules defined by the NCM Activity Database, with the cooling set-point fixed at 27°C (i.e., mixed-mode operation – see paragraph 123e) irrespective of whether the particular space in the Actual building has cooling provision or not[14]. The cooling SSEER must be taken as 2.25 (this factor includes an allowance for fan energy when the system operates so no additional auxiliary energy need be determined).

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

45. For zones with local mechanical exhaust where the fan is within the zone, the fan power density is the product of the user-defined (for the Actual building) exhaust rate and a specific fan power of 0.50 W per l/s. For zones where the mechanical exhaust fan is remote from the zone, the fan power density is the product of the user-defined exhaust rate and a specific fan power of 0.80 W per l/s. The exhaust fan energy will be an addition to the auxiliary energy from paragraph 44c.

46. In the Reference building:

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

47. The hot water system overall system efficiency (including generation and distribution) must be taken as 95%, based on the use of grid-supplied electricity (i.e., accounting for distribution losses of 5%). The energy demand in the Actual and Reference buildings must be taken as that required to raise the water temperature from 10°C to 60°C based on the demands specified in the NCM Activity Database. The Activity Database defines a daily total figure in l/(m^2.day) for each activity type. If users of DSMs wish to distribute this demand over the day, then the daily total should be distributed according to the occupancy profile.

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

49. Humidity control is ignored in both the Actual and Reference buildings.

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

Lighting power density

50. The illuminance level used for the general lighting in the Reference building is determined by the illuminance values for the activity type in the NCM Activity Database and the design illuminance for the Actual building (if input by the user) so that:

- The Reference building will use the same design illuminance input by the user for the zone in the Actual building provided the design illuminance is equal to or greater than the activity's NCM minimum lighting level (*specified in the "LIGHTING_LUX_MIN" field of the "activity" table in the database*) and does not exceed the activity's NCM maximum lighting level (*specified in the "LIGHTING_LUX_MAX" field of the "activity" table in the database*).
- Where the user does not define the design illuminance for the zone in the Actual building, or the design illuminance input for the zone in the Actual building is lower than the activity's NCM minimum lighting level, the Reference building will use the activity's NCM minimum lighting level.
- Where the design illuminance defined for the zone in the Actual building is greater than the activity's NCM maximum lighting level, the Reference building will use the activity's NCM maximum lighting level.

51. For general lighting power density in the Reference building:

a. In office, storage, and industrial spaces, divide by 100 the illuminance defined for the space as given for the activity type in the NCM Activity Database, then multiply by 3.75 W/m² per 100 lux. This includes all spaces that accommodate predominantly office tasks, including classrooms, seminar rooms, and conference rooms, including those in schools.
b. For other spaces, divide the illuminance appropriate to the activity in the space by 100, and then multiply by 5.2 W/m² per 100 lux.

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

52. Zones in the Reference building that are flagged in the NCM Activity Database as appropriate to receive local manual light control will be modelled with local manual switching (as described in the SBEMgi Technical Manual[7]) provided the floor area of the zone is less than 30 m². Otherwise, the general lighting is switched centrally based on the occupancy hours for the activity in the NCM Activity Database. Whether or not the activity is appropriate to have local manual lighting control is determined in the "activity" table from the NCM Activity Database in the "BR_CHECK02" field (*1 for activity that is NOT appropriate to have local manual control, and 0 otherwise*). Note that local manual switching only applies to general lighting (i.e., does not apply to display lighting).

53. For display lighting, where applicable in the zone, the Reference building uses the display lighting density appropriate to the activity from the NCM Activity Database.

54. The general lighting in the Reference building does not benefit from occupancy sensor control.

55. The display lighting in the Reference building does not benefit from automatic time-switch control.

56. Both general lighting and display lighting (where appropriate) in the Reference building will use the same operating profile as defined in the NCM Activity Database for each activity.

Calculating the asset rating

57. The primary energy consumption rate arising from the use of the fixed building services in the Reference building is calculated (the Reference Energy Rate or RER), to arrive at the energy performance used to normalise the primary energy consumption in the Actual building.

58. It is not intended that the definition of the Reference building should change as Part F standards change since this would mean that the energy rating of a given building would also change, even if its energy efficiency had not been varied. Therefore, the Reference building is always as defined above.

59. The Asset Rating (AR) is the ratio of the primary energy from the Actual building (i.e., the BER) to the Reference Energy Rate (i.e., RER), with the result normalised such that the RER is equivalent to an Asset Rating of 50, i.e.,

Equation 4
$$AR = 50 \times BER \;/\; RER$$

The calculated AR must be rounded to the nearest whole number, i.e., if the decimal part of the AR is less than 0.5, the AR must be rounded down; if it is 0.5 or greater, the AR must be rounded up.

60. Similarly, the Environmental Impact (EI) Rating is calculated as the ratio of the CO_2 emission rate for the Actual building to that for the Reference building, with the result normalised such that the Reference building's CO_2 emission rate is equivalent to an EI Rating of 50.

61. The following approach must be followed when calculating the RER, in kWh_{PE}/m^2 of the building's total floor area:

a. Calculate the total annual energy used by the Reference building for the fixed building services and multiply that energy use by the primary energy factor for grid-supplied electricity from **Table 18**.
b. The resulting product is the annual primary energy used to establish the RER.

62. The annual CO_2 emission rate of the Reference building, used for deriving the EI, is calculated using the same approach described in paragraph 61 but substituting the fuel's CO_2 emission factor from **Table 18** for the primary energy factor.

Constructing the rating scale

63. The A to G scale for the asset rating, in **Table 8**, is a linear scale based on two key points defined as follows:

a. The zero point on the scale is defined as the performance of the building that has zero net primary energy consumption associated with the use of the fixed building services as defined in the Building Rules. This is equivalent to a Building Energy Rate (BER) of zero.
b. The border between grade B and grade C is set at the Reference Energy Rate (RER) and given an Asset Rating of 50. Because the scale is linear, the boundary between grades D and grade E corresponds to a rating of 100.

Table 8 Rating scale and energy bands

Scale	Band
$AR < 0.0$	A+
$0.0 \leq AR \leq 25.0$	A
$25.0 < AR \leq 50.0$	B
$50.0 < AR \leq 75.0$	C
$75.0 < AR \leq 100.0$	D
$100.0 < AR \leq 125.0$	E
$125.0 < AR \leq 150.0$	F
$150.0 < AR$	G

64. The A-G scale for the EI rating is constructed is a similar manner, with the zero point on the scale defined as the performance of the building that has zero net CO_2 emissions associated with the use of the fixed building services.

Reference values and benchmarks

65. The Energy Performance Certificate must display reference values in addition to the Asset Rating. The Government has decided that the certificate should display two reference values as follows:

a. The rating of the Building Rules standard (i.e., the TER). Note this is based on improvement factors applied to the RER.
b. The rating of the "Typical" building (typical of existing stock average), whose performance is assumed to be equal to approximately twice the RER, so is 100.

Nearly-Zero-Energy Building

66. A Nearly-Zero-Energy Building (NZEB) in Gibraltar is defined as one which meets the minimum criteria set in **Table 9**:

Table 9 NZEB criteria

Building type	(Effective) Asset Rating	Renewable energy contribution (%)
Dwelling	12	50
Non-dwelling	20	40

67. The Energy Performance Certificate will report if NZEB status has been achieved by the Actual building and will display the following associated information, where applicable:

a. The proportion of the building's annual primary energy needs that is met by electricity generation from on-site renewables.
b. The proportion of the building's annual primary energy needs that is offset by the funding of renewable electricity generation elsewhere in Gibraltar (see paragraph 112).

Technical information

68. The Energy Performance Certificate must also display the following technical information about the Actual building:

c. 'Main heating fuel', which, for the purposes of the NCM, is taken as the fuel which delivers the greatest total thermal output for space or water heating.
d. 'Building environment', which is taken as the servicing strategy which contributes the largest proportion of the building's primary energy consumption.

THE ACTUAL BUILDING

69. The following paragraphs outline specific requirements for how the Actual building is modelled which apply to both SBEMgi and DSM software.

Building fabric

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

71. For SBEMgi and DSM software, the non-repeating thermal bridge heat losses for each element (including windows, etc.) in the Actual Building must be allowed for by a method that satisfies BS EN ISO 14683, or by adding 25% to the standard U-values of the Actual building.

72. Where a method that satisfies BS EN ISO 14683 is used to take account of non-repeating thermal bridges in the Actual building, the user will have the option of either directly entering the relevant Psi values or using defaults as specified in **Table 10** (*based on BRE IP 1/06*[15] *values degraded by the greater of 0.04 W/mK or 50%*). Where the user directly enters the Psi values, these values must have been calculated by a person with suitable expertise and experience[16] following the guidance set out in BR497[17] and following a process flow sequence that has been provided to Building Control, indicating the way in which the detail should be constructed.

Table 10 Default Psi values for the Actual building (W/mK)

Type of junction	Involving metal cladding	Not involving metal cladding
Roof to wall	0.42	0.18
Wall to ground floor	1.73	0.24
Wall to wall (corner)	0.38	0.14
Wall to floor (not ground floor)	0.04	0.11
Lintel above window or door	1.91	0.45
Sill below window	1.91	0.08
Jamb at window or door	1.91	0.09

73. The U-value typically quoted for a window, roof window, or roof-light is the overall U-value of the complete unit, including the frame and edge effects, and it relates to the performance of the

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

[16] ADF1 (2018)

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

unit in the vertical plane so, for roof-lights, it must be adjusted for the slope of the roof (BR443) by +0.3 W/m^{2}K if the roof is flat and +0.2 W/m^{2}K if the roof is pitched.

Lighting

74. Lighting is defined at zone level. The user sets the required general power density (W/m^2) to achieve the design illuminance in each zone provided that the design illuminance is equal to or greater than the activity's NCM minimum lighting level in the Activity Database. Where the design illuminance is lower than the activity's NCM minimum lighting level, the general power density will be automatically pro-rated (up) to the activity's NCM minimum lighting level. *For example, an office with installed lighting load density of 6 W/m² that delivers 200 lux illuminance (i.e., 3 W/m² per 100 lux) would be adjusted to 9 W/m² for the purpose of the calculation because the NCM assumes a minimum illuminance of level 300 lux for this activity.* If the user does not set the design illuminance for the zone, the activity's NCM minimum lighting level will be used for calculating the general power density in the Actual building.

75. For Building Rules compliance, the general lighting can be defined explicitly, by calculating and inputting the design/installed circuit power, or by inference. Where general lighting is defined by calculation, a maintenance factor should be applied that is appropriate to the lighting installation as defined in the Society of Light and Lighting (SLL) Lighting Handbook.

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

- **Inference method 1** - User sets the lamp efficacy in lumens per circuit-watt and the light output ratio of the luminaire to determine the efficacy of the lighting system in terms of luminaire lumens per circuit-watt, which can be pro-rated against a standard lighting curve (*which is based on 95 luminaire lumens per circuit-watt*) defined by **Equation 5** to infer a power density for the general lighting in the Actual building. The user can also input the design illuminance in the zone, if known, and the power density will then be pro-rated following paragraph 74, if applicable.

Equation 5

$$\boldsymbol{Power\ density\ per\ 100\ lux} = \boldsymbol{95/LL \times \left(1.22 + (0.005 \times R) + (0.04 \times R^2)\right) / MF}$$

Where $\boldsymbol{LL}$ is the luminaire lumens per circuit-watt, $\boldsymbol{R}$ is the ratio of the total wall area[18] to the total floor area (where the maximum value for $\boldsymbol{R}$ is 8), and $\boldsymbol{MF}$ is the maintenance factor which is taken to be 0.8. The power density per 100 lux is then multiplied by the illuminance level for the activity type, which is determined by the NCM Activity Database, and divided by 100. This equation was derived using regression analysis of parametric results produced using lighting design software for a range of space geometries and lighting systems.

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

- **Inference method 2** - User assigns a lamp type to each zone based on **Table 11**, where the luminaire efficacy can be pro-rated against the standard lighting curve defined by **Equation 5** to infer a power density for the general lighting in the Actual building. The user can also input the design illuminance in the zone, if known, and the power density will then be pro-rated following paragraph 74, if applicable.

Table 11 Lamp inference data

Lamp type	Luminaire lumens per circuit-watt For all buildings[19]	
	Side-lit and unlit activities	**Top-lit activity**
LED	50.0	50.0
Tungsten and Halogen	7.5	9.0
Fluorescent - compact	22.5	27.0
T12 Fluorescent - halophosphate - low frequency ballast	25.0	30.0
T8 Fluorescent - halophosphate - low frequency ballast	27.5	33.0
T8 Fluorescent - halophosphate - high frequency ballast	32.5	39.0
T8 Fluorescent - triphosphor - high frequency ballast	36.3	43.5
Metal Halide	25.0	39.0
High Pressure Mercury	22.5	27.0
High Pressure Sodium	35.0	42.0
T5 Fluorescent - triphosphorcoated - high frequency ballast	37.5	45.0
Fluorescent (no details)	22.5	27.0

77. The general lighting in the Actual building will include the capability of modelling daylight harvesting, local manual switching (where appropriate[20]), and occupancy sensor control (as defined in the SBEMgi Technical Manual[7]). It will also include the capability of modelling constant illuminance control (as defined in BS EN 15193:2007[21]) by reducing the general lighting power density by 10%, if applicable.

78. The daylight contribution from display windows should be included in the consideration of daylight harvesting.

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

[20] Whether or not the activity is appropriate to have local manual control is determined in the “activity” table from the NCM Activity Database.

[21] BS EN 15193:2007 - Energy performance of buildings - Energy requirements for Lighting.

79. Display lighting will be defined in terms of the average display lighting lamp efficacy for each zone, which will be pro-rated against an efficacy of 15 lamp lumens per circuit-watt to adjust the NCM display lighting power density value associated with the activity in the Activity Database.

80. There will be an option for assigning automatic time-switching control at zone level for display lighting in the Actual building that will result in the annual display lighting energy being reduced by 20%.

81. Both general lighting and display lighting (where appropriate) will use the same operating profile as defined in the NCM Activity Database for each activity.

Auxiliary energy

82. The following paragraphs outline how auxiliary energy should be calculated in both SBEMgi and DSM software.

83. DSM software should not allow the user to directly set the auxiliary power density. The users of DSM software should only be allowed to define the HVAC systems type, specific fan powers, and associated controls (i.e., demand control of ventilation, variable speed pumping, etc.).

84. The auxiliary energy is the product of the auxiliary power density and annual hours of operation of the heating system from the NCM Activity Database (*i.e., the hours when the heating set-point is above the set-back temperature based on the daily/weekly/annual schedules or the "SYS_HEAT_T_HOURS_#"*[13] *fields from the "activity_sbem_D1_ACU" table in the NCM Activity Database*).

85. The auxiliary power density is the sum of the pump and fan power densities.

86. The pump power density for the Actual building will depend on the type of HVAC system and whether the pump has variable speed control. **Table 12** determines which HVAC system types need to account for pump power and whether the option of specifying variable speed pumping is made available to the user. **Table 13** gives the pump power densities for constant speed pumping as well as variable speed pumping.

Table 12 Assigning pump power to HVAC systems

HVAC system type	Pump power	Variable speed pumping allowed
Central heating using water: radiators	LTHW only	Yes
Central heating using water: convectors	LTHW only	Yes
Central heating using water: floor heating	LTHW only	Yes
Central heating with air distribution	None	No
Other local room heater - fanned	None	No
Other local room heater - unfanned	None	No

Table 12 Assigning pump power to HVAC systems		
HVAC system type	**Pump power**	**Variable speed pumping allowed**
Unflued radiant heater	None	No
Flued radiant heater	None	No
Multiburner radiant heaters	None	No
Flued forced-convection air heaters	None	No
Unflued forced-convection air heaters	None	No
Single-duct VAV	Both LTHW and CHW	No
Dual-duct VAV	Both LTHW and CHW	No
Indoor packaged cabinet (VAV)	Both LTHW and CHW	Yes
Fan coil systems	Both LTHW and CHW	Yes
Induction system	Both LTHW and CHW	Yes
Constant volume system (fixed fresh air rate)	Both LTHW and CHW	No
Constant volume system (variable fresh air rate)	Both LTHW and CHW	No
Multizone (hot deck/cold deck)	Both LTHW and CHW	No
Terminal reheat (constant volume)	Both LTHW and CHW	No
Dual duct (constant volume)	Both LTHW and CHW	No
Chilled ceilings or passive chilled beams and displacement ventilation	Both LTHW and CHW	Yes
Active chilled beams	Both LTHW and CHW	Yes
Water loop heat pump	Both LTHW and CHW	No
Split or multi-split system	None	No
Single room cooling system	None	No
Variable refrigerant flow	None	No
Chilled ceilings or passive chilled beams and displacement ventilation	Both LTHW and CHW	Yes
Chilled ceilings or passive chilled beams and mixing ventilation	Both LTHW and CHW	Yes

Table 13 Pump power density for Actual building (W/m²)		
Pump configuration	**LTHW only**	**Both LTHW and CHW**
Constant speed pumping	0.6	1.8
Variable speed pumping with differential sensor across pump	0.5	1.5
Variable speed pumping with differential sensor in the system	0.4	1.1
Variable speed pumping with multiple pressure sensors in the system	0.3	0.9

87. For zones where the ventilation system also provides heating and/or cooling, the fan power density is determined for each zone using one of the following equations as determined by **Table 14**:

Equation 6 $FPS_1 = (FAR_{max} \times SFP_{central}) + (SCR \times SFP_{terminal})$

Equation 7 $FPS_2 = \textit{Greater of } (FAR_{max}, SCR) \times SFP_{central}$

Equation 8 $FPS_3 = \textit{Greater of } \big((SCR/5), FAR_{max}\big) \times SFP_{central}$

Equation 9 $FPS_4 = FAR_{max} \times SFP_{central}$

Equation 10 $FPS_5 = 0.85 \times FAR_{max} \times SFP_{central}$

where:

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

Equation 11 $SCR = \textit{Greater of } (PSH, PSC) \,/\, (\rho \times C_p \times \Delta T)$

where:

ρ =1.2 kg/m³, C_p =1.018 kJ/kgK, and ΔT =8K,

"PSH" is the peak space heating load, and "PSC" is the peak space cooling load (i.e., in W/m² of floor area for each zone). For both parameters, the effects of thermal mass will be ignored. The peak space heating load is the sum of the peak steady state fabric losses and air losses (infiltration/ventilation load) based on an external ambient of 0°C.
For SBEMgi, the peak space cooling load is the sum of peak internal gains, which will include occupancy, equipment, general lighting, display lighting, and peak solar gains. The peak solar gain is calculated using the solar data for September from Table 2.30 of CIBSE Guide A (using the beam and diffuse solar for each hour between 06:30 and 18:30). The total solar gain for each zone is calculated and peak hour is used. DSMs are allowed to use the peak solar calculated during simulation.

88. The fan power density equations are assigned to HVAC systems based on **Table 14**.

Table 14 Assigning fan power equations to HVAC systems	
HVAC system type	**Fan power density**
Fan coil systems	Equation 6
Indoor packaged cabinet (VAV)	
Central heating using air distribution	Equation 7
Constant volume system (fixed fresh air rate)	
Constant volume system (variable fresh air rate)	
Single-duct VAV	
Water loop heat pump	
Dual duct (constant volume)	
Multi-zone (hot deck/cold deck)	
Terminal reheat (constant volume)	
Dual-duct VAV	
Active chilled beams	Equation 8
Induction system	
Variable refrigerant flow	Equation 9
Chilled ceilings or passive chilled beams and mixing ventilation	
Chilled ceilings or passive chilled beams and displacement ventilation[22]	Equation 10

89. For zones where the ventilation system does not provide heating or cooling (but can include heat recovery), the fan power density is the product of the fresh air supply rate for the activity type from the NCM Activity Database and the specific fan power defined by the user at zone level.

90. For zones with mechanical exhaust, the fan power density is the product of the user-defined exhaust rate and the specific fan power defined by the user. The exhaust fan energy will be an addition to the fan energy for supply & extract ventilation. Note that the user defined exhaust rate is not considered in the air load calculations.

91. For zones served by the HVAC systems listed in **Table 15**, additional fan energy is included to account for integral fans, using the ratio (to be input by the user) of associated fan power, in W per kW of heat output (delivered) by the heating system.

Table 15 Additional fan power for specific HVAC systems	
HVAC system type	**iSBEMgi ID**
Central heating using water: convectors (*but only in case the system utilises fanned convectors)*	24
Other local room heater - fanned	3

[22] Displacement ventilation is assumed to reduce the required airflow by 15% compared to mixing ventilation.

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

DEMAND CONTROL OF VENTILATION

93. The Actual building will include the ability to model demand control of ventilation for zones with mechanical ventilation (but excluding exhaust-only systems) while for naturally ventilated zones, there will be the option of enhanced ventilation control (this refers to natural ventilation with BMS control, i.e., modifying the ventilation flow rate provided by natural means in the space based on some form of control). The details for implementing demand-controlled ventilation (as defined in the SBEMgi Technical Manual[7]) are outlined below.

94. For zones with mechanical ventilation (but excluding exhaust-only ventilation), the following options will be available to the user:

a) No demand-controlled ventilation *(default option)*
b) Demand control based on occupancy density
c) Demand control based on gas sensors

95. If the option selected is either b) or c) from above, then the parameter "air flow regulation type" will become active with the following options available to the user:

a) Damper control *(default option)*
b) Speed control

96. For zones with natural ventilation, the following options will be available to the user:

a) No demand-controlled ventilation *(default option)*
b) Enhanced ventilation

97. Depending on user inputs, a modified demand control fresh air rate ($\boldsymbol{FAR_{dc}}$) is determined from the NCM fresh air rate ($\boldsymbol{FAR_{max}}$) for the activity.

Equation 12 $$\boldsymbol{FAR_{dc} = (C_{dc} \times FAR_{lower}) + \left((1 - C_{dc}) \times FAR_{max}\right)}$$

where:

$\boldsymbol{FAR_{max}}$ is the ventilation rate per person from the NCM Activity Database multiplied by the peak occupancy density during the occupied period (i.e., l/s per m²), $\boldsymbol{C_{dc}}$ is a demand control coefficient which is determined based on the data in **Table 16***,* and $\boldsymbol{FAR_{lower}}$ is calculated as follows:

Equation 13 $$\boldsymbol{FAR_{lower} = Greater\ of\ \left(FAR_{min}, (0.6 \times FAR_{max})\right)}$$

where:

$\boldsymbol{FAR_{min}}$ is the ventilation rate per person from the NCM Activity Database multiplied by the minimum occupancy density during the occupied period (i.e., this can be zero for some activities), in l/s per m².

Table 16 Values for demand control coefficient	
Type of demand control	**Demand control coefficient (C_{dc})**
None	0
Control based on occupancy density	0.85
Control based on gas sensor	0.95
Enhanced natural ventilation	0.50

98. In addition to affecting the fresh air load (i.e., energy to heat and cool the fresh air), demand control of ventilation can also affect the auxiliary energy. Where there is demand control of ventilation, the auxiliary energy calculation will use $\boldsymbol{FAR_{max}}$ pro-rated by a value obtained from **Table 17**, depending on the type of control for air regulation and the ratio of modified fresh air rate to maximum fresh air rate (i.e., $\boldsymbol{FAR_{dc}/FAR_{max}}$).

Table 17 Proportion of maximum fan power in case of demand control of ventilation[23]						
$\boldsymbol{FAR_{dc}/FAR_{max}}$	**0**	**0.2**	**0.4**	**0.6**	**0.8**	**1**
Air flow regulation type						
Damper control*	0	0.525	0.65	0.8	1	1
Speed control	0	0.1	0.18	0.35	0.65	1
*Average of forward and backward blades. Use linear interpolation for intermediate values of $\boldsymbol{FAR_{dc}/FAR_{max}}$.						

Building energy rate (BER)

99. The following approach must be followed when calculating the primary energy rate of the Actual building, in kWh_{PE}/m^2 of the building's total floor area.

a. Calculate the annual electrical energy used by the Actual building irrespective of source of supply. Multiply that energy use by the primary energy factor for grid-supplied electricity from **Table 18**.
b. Calculate the annual energy associated with any other fuels used in the Actual building, including any fuel used in generating the electricity (e.g., in a CHP generator), and multiply the energy use by the respective primary energy factors for the fuels from **Table 18**.
c. Calculate the annual electricity generated by any on-site renewable energy systems, for e.g., PV, wind, or CHP generators, and multiply that by the primary energy factor for grid-displaced electricity from **Table 18** (irrespective of the proportion of electricity that is used on site and how much is exported).
d. The net figure of 'a *plus* b *minus* c' above is the annual primary energy used to establish the BER.

[23] Adapted from BS EN 15241:2007 - Ventilation for buildings.

100. The net CO_2 emissions of the Actual building, for the purposes of deriving the EI, are calculated using the same approach described in paragraph 99 but substituting the fuels' CO_2 emission factors from **Table 18** for the primary energy factors.

101. Similarly, net energy costs for the Actual building are calculated, for the purposes of reporting on the EPC, using the same approach described in paragraph 99 but substituting the fuels' unit prices from **Table 18** for the primary energy factors.

APPENDIX A - INPUT DATA TO APPROVED TOOLS

102. This section of the guide describes generally-applicable approaches to data input and modelling strategies, and it applies equally to Building Rules compliance and EPCs and also to the modelling of both the Actual and Reference buildings.

Defining internal gains and environmental conditions

103. To facilitate estimating energy performance on a consistent basis, a key part of the NCM is an Activity Database that defines the activities in various types of space in different classes of building[24] (which closely aligned with the UK Town and Country Planning (TCP) Use Classes[25]). One of these standard activities must be assigned to each space in the building[26].

104. The most recent version of the NCM Activity Database to accompany the NCM Modelling Guide for Gibraltar was updated in 2024.

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

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

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

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[24] The NCM databases (Activity, Construction, and Glazing) can be downloaded from https://www.epc.gov.gi/GIEpc/100/

[25] Town and Country Planning (Use Classes) Order 1987 as amended. The Town and Country Planning (Use Classes) (Amendment) (England) Regulations 2020 came into force on 1st September 2020 and amended the Town and Country Planning (Use Classes) Order 1987 https://www.planningportal.co.uk/info/200130/common_projects/9/change_of_use.

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

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

107. If there is not an activity in the database that reasonably matches the intended use of a space, then this could be raised with the database managers (see NCM databases[18] for details), and an appropriate new activity may be proposed. This will be subject to peer review prior to formal acceptance into the database. Note that it is NOT acceptable for users to define and use their own activities. Consistent and auditable activity schedules are an important element of the compliance and certification processes, and so only approved activity definitions can be used for these purposes[27]. If a special-use space is present in the Actual building, and no appropriate activity is available in the database, it is accepted that time pressures may preclude waiting for the specific activity definition to be developed, peer reviewed, and approved. In such situations, the Energy Assessor must select the closest match from the approved existing database. Because compliance and certification are both based on the performance of the Actual building in comparison to that of a Reference building, the impact of this approximation should be minimised.

Constructions

108. The thermal performance of construction elements must take account of thermal bridges:

a. Repeating thermal bridges must be included in the calculated plane element U-value as detailed in BR443[3]. Simulation tools that use layer-by-layer definitions will need to adjust thicknesses of insulation layers to achieve the U-value that accounts for the repeating thermal bridges.
b. Non-repeating thermal bridges should be dealt with in the Actual Building by a method that satisfies BS EN ISO 14683, or by adding the percentage specified in paragraph 71 to the standard U-values of the Actual building.

109. Available on the Gibraltar EPC website are databases of calculated U-values, etc. (NCM Construction database and NCM Glazing database), and for consistency, all implementations of the NCM should preferably use these databases. It is accepted that a required construction may not always exist in the NCM database. In such cases, alternative sources of data may be used, but the person submitting for Building Rules approval must declare this and demonstrate how the values were derived.

110. When using the software tool to generate an EPC, the performance parameters for some constructions may not be known. In such situations, the parameters must be inferred based on the data provided in the NCM Construction Database. This is an important aspect of ensuring consistency in energy rating calculations, and so all software tools must adopt these procedures. This will be checked as part of the approval process.

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[27] Clearly, designers may wish to use alternative bespoke schedules for particular design assessments, but these exist outside the compliance/certification framework.

Renewable electricity

111. The performance of the Actual building can be improved by the use of electricity generated by renewable systems, usually photovoltaic panels, in one of two ways:

a. On-site – where the PV panels are installed on or very close to the building and connected directly to it. In this case, the specification of the panels, in terms of area, cell type (or peak power, if known), orientation, and over-shading will determine the annual contribution, using the standard SBEMgi modelling routines.
b. Off-site – where the building designer off-sets some of the building's electricity load by purchasing a certain amount of accredited peak generation capacity, to be installed elsewhere in Gibraltar. The software will use the peak capacity, expressed as kW_{peak}, to calculate an average estimated annual amount of generated electricity, in kWh, using a standard conversion factor that is based on average installations across Gibraltar. This conversion factor is currently set at 1499 kWh/kW_{peak} per annum.

112. When calculating an EPC rating, only the on-site component is taken into account initially. Where off-site generation is also accredited, the Energy Performance Certificate will state the effective rating which would be achieved if the relevant amount of generated electricity were taken into account.

113. When assessing compliance with Building Rules, the headline BER will include only the on-site renewables. The compliance report will, however, also indicate the effective BER which would have been achieved if the off-site renewables were taken into account. This effective BER is expected normally to be the value compared with the TER for compliance purposes.

Weather location

114. In order to calculate the reaction of the building and systems to the variable loads imposed by the external environment, the NCM needs an input of weather data. One standard weather set for Gibraltar has been adopted for use in all Gibraltar calculations.

Zoning rules

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

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

a. As specified in the following general guidance (see paragraphs 117 to 121); or

b. Where specific limitations are imposed by the modelling tool that is being used (e.g., where a tool only permits each modelled zone to comprise one thermal zone and one lighting zone).

Zone types

117. A thermal zone is an area that:

a. Has the same heating and cooling set-points; and
b. The same ventilation provisions; and
c. Has the same plant operating times; and
d. Has the same set-back conditions; and
e. Is served by the same type(s) of terminal device; and
f. Is served by the same primary plant; and
g. Where the output of each type of terminal device is controlled in a similar manner.

118. A lighting zone is an area that:

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

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

Combining adjoining thermal zones

120. Adjoining thermal zones (horizontally or vertically[28]) may be combined into a single larger zone provided that:

a. The zones are all the same in terms of the characteristics defined in paragraph 117 above; and
b. The zones all have the same combination of activities inside them; and
c. The zones all have the same combination of lighting zones within them; and
d. The zones all have the same exposure to the external environment in terms of glazing percentages, glazing types, and orientation.

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

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

Fuel emission and primary energy factors

122. The CO_2 emission factors[29] and primary energy factors[30] for fuels used (and generated) in the Actual and Reference buildings will be as defined in **Table 18**, which also includes a column for fuel cost.

Table 18 Fuel CO_2 emission and primary energy factors and cost for fuels in Gibraltar

Fuel type	$kgCO_2/kWh$	kWh_{PE}/kWh	Pence/kWh
Natural gas	0.216	1.22	2.82
LPG	0.234	1.07	5.24
Biogas	0.098	1.1	5.33
Fuel oil	0.319	1.1	4.01
Coal	0.345	1	2.55
Anthracite	0.394	1	2.5
Manufactured smokeless fuel (inc. Coke)	0.433	1.21	3.28
Dual fuel (mineral + wood)	0.226	1.02	2.77
Biomass	0.031	1.01	5.33
Grid supplied electricity	0.575	3.01	10.61
Grid displaced electricity	0.575	3.01	10.61
Waste heat[31]	0.058	1.34	2.41
District heating	*User input*	*User input*	3.44

HVAC

123. In the context of this guide, "servicing strategy" means the broad category of environmental control, summarised as follows:

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

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29 These are CO_2 equivalent figures which include the global warming impact of CH_4 and N_2O as well as CO_2.

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

31 This includes waste heat from industrial processes and power stations

124. A space is only considered as having air-conditioning if the system serving that space includes refrigeration. Night cooling using mechanical ventilation is not air-conditioning. If the same mechanical ventilation system that is used for night cooling is also used to provide normal ventilation, then the space should be regarded as being mechanically ventilated. Any boosted supply rate required to limit overheating must be ignored in the Notional and Actual buildings. If the mechanical ventilation system only operates in peak summer conditions to control overheating, and during normal conditions, ventilation is provided naturally, then the space must be regarded as naturally ventilated, and the mechanical ventilation system can be ignored in both the Notional and Actual buildings.

125. For the Actual building, DSMs may represent HVAC systems explicitly but will be required to report system seasonal performance parameters as an aid to checking (see paragraph 3c).

126. For DSMs that model HVAC with temperature control bands, the activity cooling/heating set-points from the NCM Activity Database should be used as the mid-band point, and the control band should be ±0.5°K or less.

Lighting

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

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

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

Adjustment factors

130. Where applicable, adjustment factors for enhanced management and control features from ADF1 (2018), should be applied using the following approach:

a. Apply the adjustment factor due to power factor correction to the CO_2 emissions and primary energy consumption which are attributed to grid electricity in the building.
b. Apply the adjustment factor due to automatic monitoring and targeting with alarms for out-of-range values to the energy consumption attributed to the lighting or HVAC system with the M&T feature.

Measurement and other conventions

131. In order to provide consistency of application, standard measurement conventions must be used. These apply to both DSMs and software interfaces to SBEMgi, although some parameters may only relate to the latter. These conventions are specified in **Table 19** below:

Table 19 Measurement and other conventions

Parameter	Definition
Zone Area	Floor area of zone calculated using the internal horizontal dimensions between the internal surfaces of the external zone walls and half-way through the thickness of the internal zone walls. Used to multiply area-related parameters in databases. NB: If the zone has any virtual boundaries, e.g., no walls in certain orientations, the area of the zone is that delimited by the 'line' defining the virtual boundary.
Envelope Area	Area of vertical envelopes (walls) = h × w, where: h = floor to floor height, i.e., including floor void, ceiling void, and floor slab. For top floors, h is the height from the floor to the average height of the structural ceiling. w = horizontal dimension of wall. Limits for that horizontal dimension are defined by type of adjacent walls. If the adjacent wall is external, the limit will be the internal side of the adjacent wall. If the adjacent wall is internal, the limit will be half-way through its thickness. NB: Areas of floors, ceilings, and flat roofs are calculated in the same manner as the zone area. Area for an exposed pitched roof (i.e., without an internal horizontal ceiling) will be the inner pitched surface area of the roof.
Window Area	Area of the structural opening in the wall/roof; the area, therefore, includes the area of glass + frame.
HWS Dead-leg Length	Length of the draw-off pipe to the outlet in the space (only used for zones where the water is drawn off). Used to determine the additional volume of water to be heated because the cold water in the dead-leg has to be drawn off before hot water is obtained. Assumes that HWS circulation maintains hot water up to the boundary of the zone, or that the pipe runs from circulation or storage vessel within the zone.
Flat Roof	Roof with pitch of 10^{o} or less. If greater than 10^{o}, the roof is a pitched roof.
Pitched Roof	Roof with pitch greater than 10^{o} and less than or equal to 70^{o}. If the pitch is greater than 70^{o}, it must be considered a wall.
Glazed door	When doors have more than 50% glazing, then the light/solar gain characteristics must be included in the calculation. This is achieved by defining these doors as windows and accounting for the opaque part in the frame factor parameter.
Curtain walling	Fully glazed curtain walling systems should be modelled as glazing, where the spandrel area (i.e., non-vision areas) can be accounted for in the frame factor parameter.

APPENDIX B – EPBD RECAST

132. This section describes the added requirements of the recast Energy Performance of Buildings Directive (EPBD2) with regards to the building design and compliance output report.

Alternative energy systems

133. The approved software tool will include additional questions for the user to confirm that the designers have considered, in the new building design, the technical, environmental, and economic feasibility of 'high-efficiency alternative systems', as defined in the recast EPBD (renewable energy systems, CHP, district heating/cooling, or heat pumps), and to confirm that there is documentary evidence of the feasibility assessment. They should also be asked if they have included any such systems in the proposed design solution. The answers to these questions will be reported in the compliance output document summary.