Interim NZEB Performance Specification Calculation Methodology

Q1 2018

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1 Introduction

This document details the methodology to be used for the calculation of the energy performance coefficient (EPC), carbon performance coefficient (CPC) and Renewable Energy Ratio (RER) based on the Interim NZEB Performance Specification for new buildings owned and occupied by Public Authorities.

Article 9 of the Energy Performance of Buildings Directive requires that

"Member States shall ensure that:

(a) by 31 December 2020, all new buildings are nearly zero-energy buildings, and

(b) after 31 December 2018, new buildings occupied and owned by public authorities are nearly zero-energy buildings."

Art 9**(a)** of the Directive for all new buildings to be Nearly Zero by 31ST December 2020 is being implemented through Part L of the Building Regulations.

TGD L (2017) for Buildings other than Dwellings was published on 22nd December 2017. The TGD L advises on page 5 that the document sets the "*minimum energy performance requirements for buildings and the application of these requirements to new buildings to achieve Nearly Zero Energy Buildings;"*.
In the "Transitional Arrangements" section on page 6, it also advises that these provisions apply to works commencing from 1st January 2019 subject to the transition arrangements therein.

For buildings occupied and owned by Public Authorities a circular was issued to all government Departments in December 2016 advising them to apply the NZEB Interim Specification to buildings commencing design from 1st January 2017 in order to implement Article 9(**b**). It is a matter for the parent Department to agree with their design teams the implementation of this circular and to identify those buildings which commenced design in January 2017 and which are subject to the NZEB Interim Specification.

The Interim NZEB specification is intended for use by Public Authorities for any buildings owned and occupied by public authorities which were to commence design after January 2017. All new buildings which commence construction after 1st Jan 2019 are subject to the transition arrangements in TGD L 2017-Buildings other than dwellings.

Please note that final responsibility for enforcement of Building Regulations rests with Local Authority Building Control.

Where the Interim NZEB Performance Specification for new buildings owned and occupied by Public Authorities is applicable, the step by step methodology is as follows:

1. Calculate the performance of the proposed buildings in SBEM V3.5b using the Interim Public Sector Specification for fabric and services. This must be done manually using "table 1" from draft interim specification with same size and shape as actual building. This then becomes the reference building.
2. Calculate the performance of the actual building in SBEM V3.5b using the actual specification for fabric and services.

3. Compare the primary energy (kWh/m2/yr) and carbon dioxide emissions (kgCO2/m2/yr) between the building modelled with actual performance specification and the building modelled with the Interim Public performance specification.
4. Where the actual building performance specification has a primary energy performance equal to, or lower than the primary energy performance (kWh/m2/yr) of the same building modelled using the Interim Public Sector Specification it achieves the NZEB performance specification for energy i.e.

   $$\text{EPC} = \frac{\text{Primary Energy of Actual Building}}{\text{Primary Energy of reference building}}$$

   Must be equal to or less than MPEPC =1.0
5. Where the actual building performance has a carbon dioxide emissions performance equal to, or lower than 1.15 times the carbon dioxide performance (kgCO2/m2/yr) of the building modelled using the Interim Public Sector Specification it achieves the NZEB performance specification for carbon dioxide emissions.

   $$\text{CPC} = \frac{\text{Primary Carbon Dioxide emissions of Actual Building}}{\text{Primary Carbon Dioxide emissions of reference building}}$$

   Must be equal to or less than MPCPC =1.15
6. The Renewable Energy Ratio (RER) should be as follows:
   a. Where the MPEPC of 1.0 and MPCPC of 1.15 is achieved an RER of 0.20 represents a very significant level of energy provision from renewable energy technologies
   b. Where the MPEPC of 0.9 and MPCPC of 1.04 is achieved an RER of 0.10 represents a very significant level of energy provision from renewable energy technologies

2 Reference Building

The actual building is entered into the SBEM V3.5b software, the file is then saved as a separate file which will be the Reference Building file and the following adjustments are made.

2.1 Project Database

- The U values of all heat loss elements, including internal elements adjoining unheated spaces and strongly ventilated spaces are updated based on specification from Table 1 of Interim NZEB Performance Specification
- The thermal capacity (Km values) of all elements should be the same as Reference Building in the 2008 Technical Guidance Document for Part L.

External Wall	11.7 kJ/m2K
Roof	12.0 kJ/m2K
Ground Floor	36.0 kJ/m2K
Internal Wall	11.9 kJ/m2K
Internal floor	8.6 kJ/m2K
Internal ceiling	8.6 kJ/m2K

- The G-Value and Light Transmittance of all glazing are based on specification from Table 1 of Interim NZEB Performance Specification
- All internal/ non heat loss elements should have the same U value as actual building.

2.2 Geometry

- The Global Thermal Bridges are updated based on Table 2 of Interim NZEB Performance Specification. In iSBEM V3.5b this will require that "Accredited Detail" is ticked for all and the "Junctions involving metal cladding" are user defined to meet Table 2 of Interim NZEB Performance Specification, refer to Figure 1 for example.

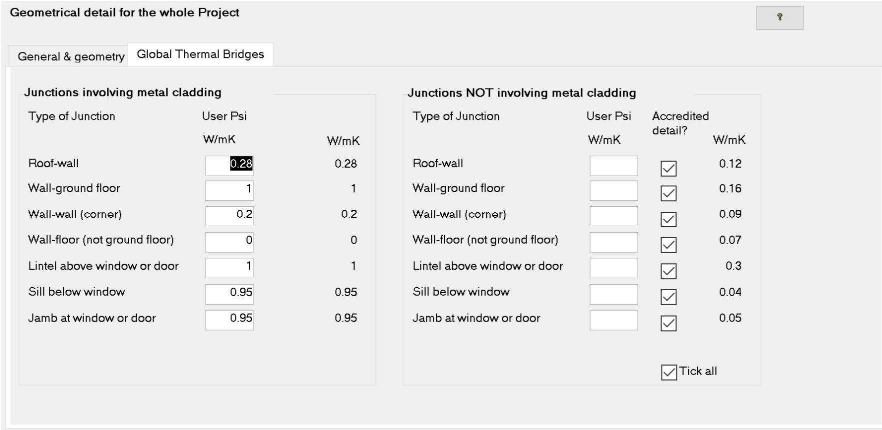

Figure 1 Global Thermal Bridges

- Air Permeability is updated based on Table 1 of Interim NZEB Performance Specification by selecting "Yes, Air permeability at 50pa is" is selected and value from Table 1 entered depending on building size.

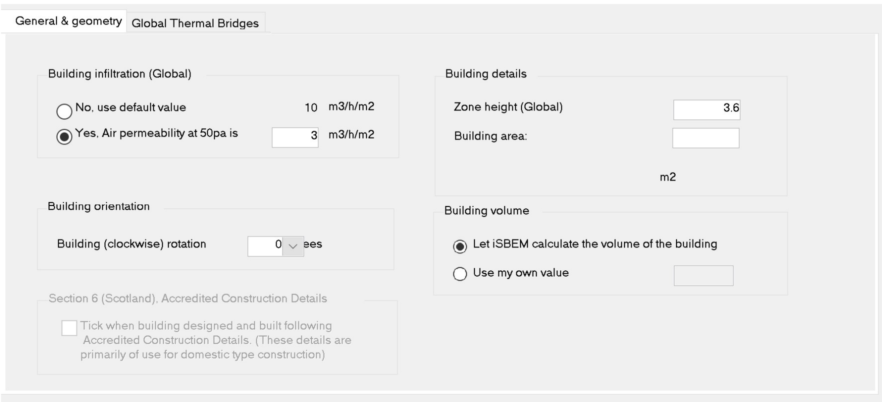

Figure 2: Building Infiltration

- All zones are updated to use non default value for Infiltration and Global Psi values, refer to Figure 3.

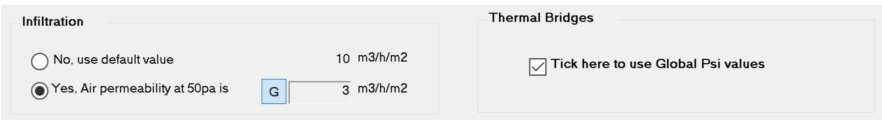

Figure 3: Zone Infiltration and Thermal Bridges

- Floor area and building volume are same as actual building
- Rooflights and windows based on reference building type:

a) sidelit through vertical windows (offices, halls of residence etc.). These have 40% glazing with 10% framing factor;

b) toplit through rooflights (warehouses, industrial buildings etc). These are 12% glazed with 30% framing factor;

c) no glazing (theatres, cinemas etc).

For example, referring to Figure 4, Z0/01 below is a zone which is sidelit by a window on one elevation (Z0/01/s) but has three external wall elements. The zone is 3m high.

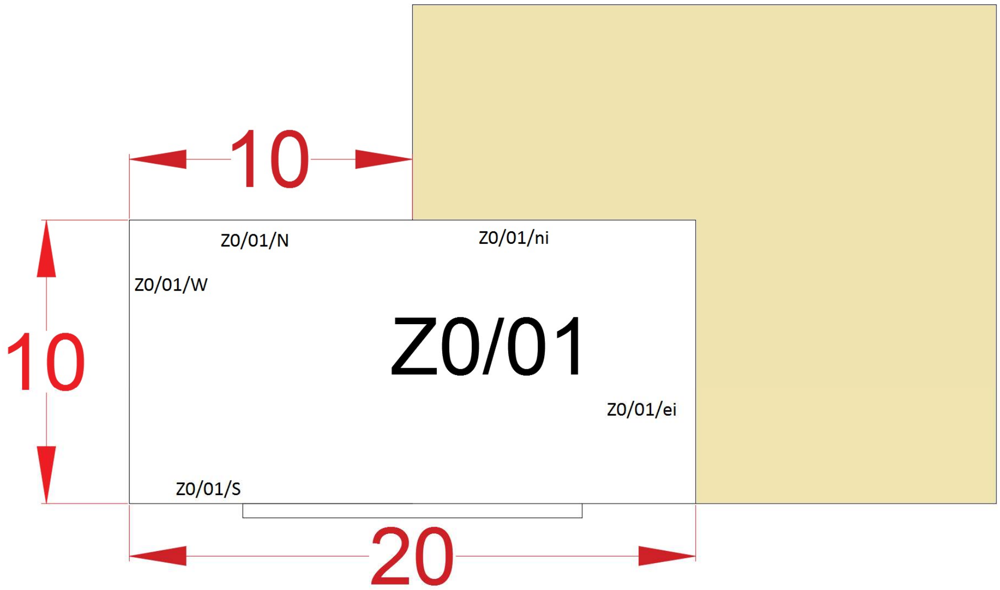

Figure 4 Window Example

Within SBEM the glazing will have to be updated as follows:
Z0/01/s: The glazing area should be modified to 24m2 (40% of 20m x 3m)
Z0/01/w: Glazing needs to be added to the elevation equal to 12m2 (40% of 10m x 3m)
Z0/01/n: Glazing needs to be added to the elevation equal to 12m2 (40% of 10m x 3m)

- Wall, Roof, Ceiling and Door Area are same as actual building.
- Shading and orientation are same as actual building

2.3 HVAC Systems

- Metering Provision for Lighting and HVAC should be set to “No”.
- HVAC type should be as per actual building, with the exception of where cooling is present, the system should be adjusted to meet SSEER for cooling.
- Heating Source and Fuel Type should be gas fired boiler with efficiency adjusted based on Table 1 of Interim NZEB Specification, as detailed below.

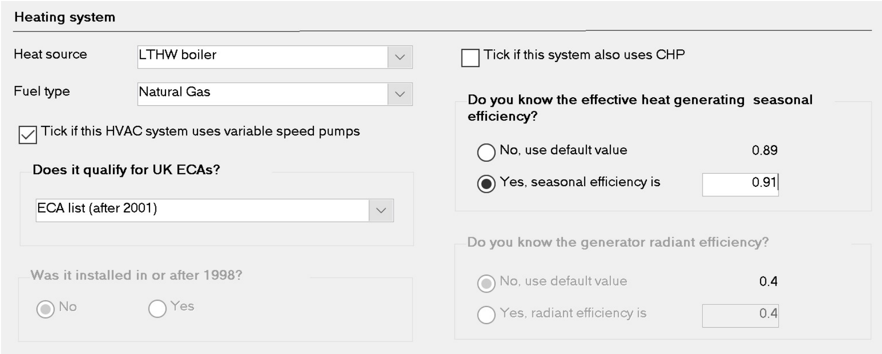

Figure 5: Heating system for Reference Building

- Cooling Source should be as per actual building with efficiency adjusted based on Table 1 of Interim NZEB Specification, fuel type is always electricity.
  Note the SSEER should be verified based on "Approved Documents Checks" for the ACTUAL building.

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] Active chilled beams, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Grid Supplied Electricity										
	Actual	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3.58	0.91	4.5
	Reference	259.2	168	92.3	20.7	9.5	0.78	2.25	----	----

Figure 6 Approved Documents Checks

An example of how the SSEER is achieved is the use of **Active Chilled Beam** system, the following are the inputs into SBEM to achieve the SSEER of 3.6.

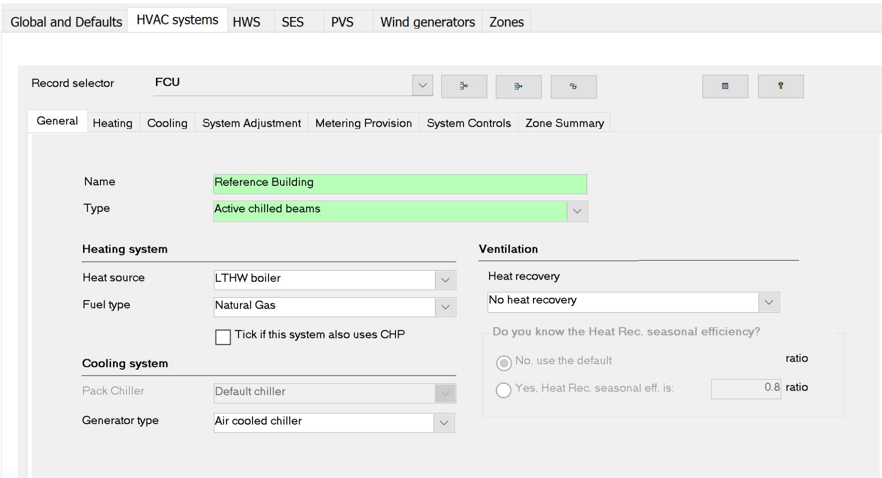

Figure 7 HVAC Type for Reference Building to achieve SSEER of 3.6

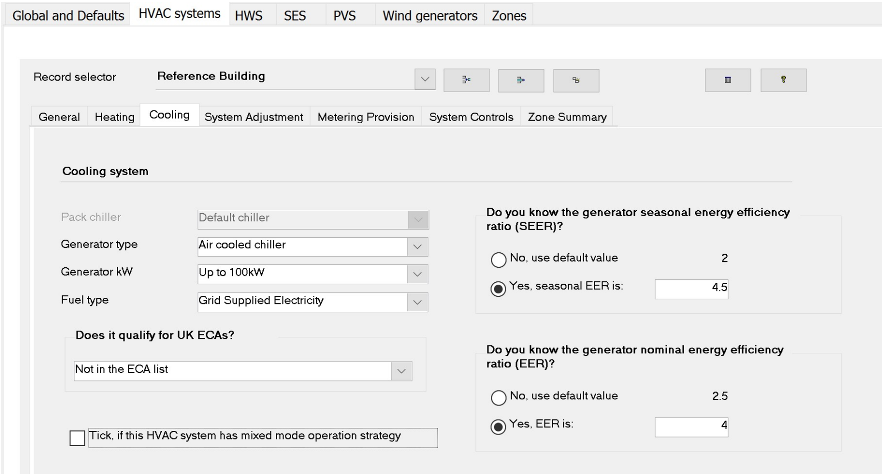

Figure 8 Cooling Type for Reference Building to achieve SSEER of 3.6

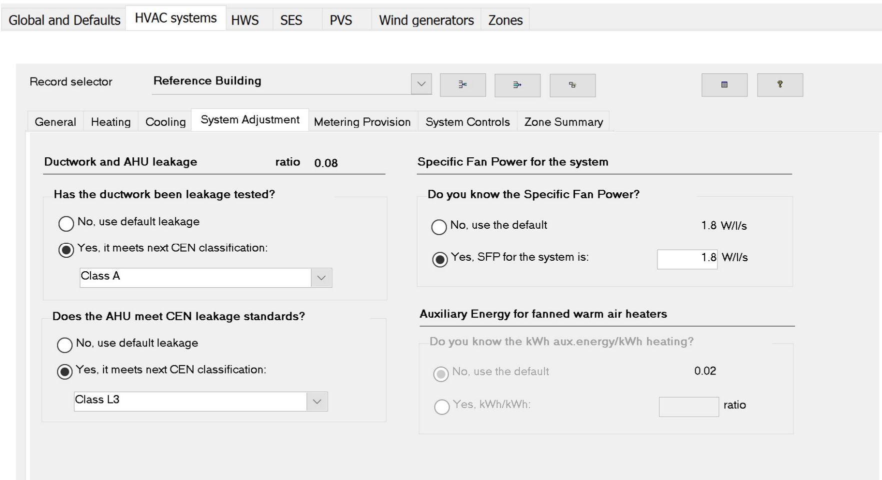

Figure 9 System Adjustment Type for Reference Building to achieve SSEER of 3.6

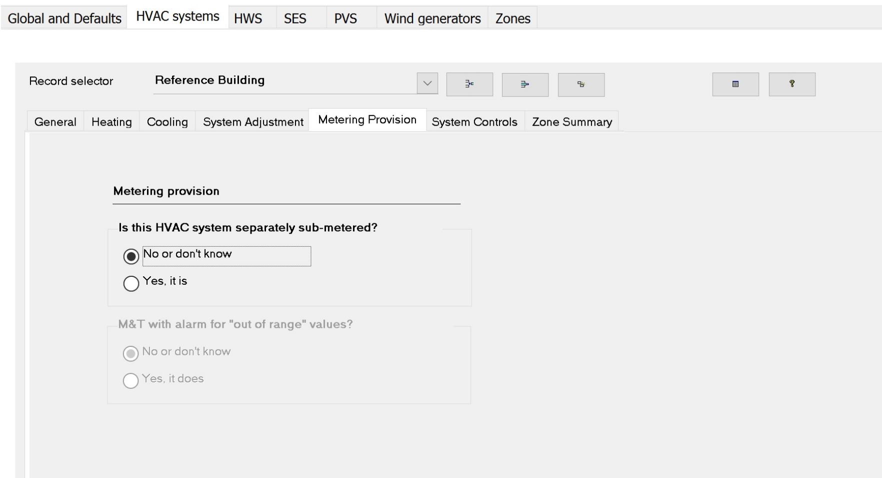

Figure 10 Metering Provision for Reference Building to achieve SSEER of 3.6

- Ductwork and AHU Leakage should be set to “Default” or where necessary adjusted to meet the SSEER of the reference building.
- Specific Fan Power (SFP) should be adjusted based on Table 1 of Interim NZEB Specification
- No Heat Recovery should be selected
- Demand Control Ventilation cannot be entered in the current version of SBEM

2.4 HWS Systems

- HWS type should be as per actual building
- Generator Type and Fuel Type should be gas fired boiler with efficiency adjusted based on Table 1 of Interim NZEB Specification, as detailed below.

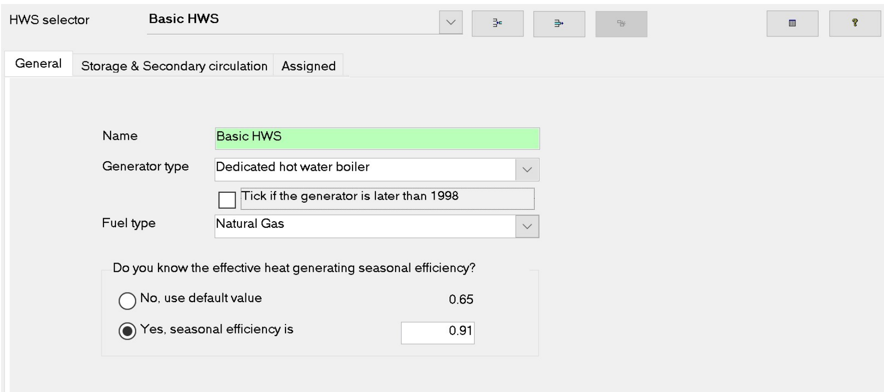

Figure 11 HWS Source for Reference Building

- Storage & Secondary circulation should be as per Actual Building

2.5 Zones

- The presence of Ventilation and Exhaust should be as per actual building
- Specific Fan Power (SFP) should be adjusted based on Table 1 of Interim NZEB Specification
- Ventilation flow rate should be as per actual building.
- No Heat Recovery should be selected
- Lighting should be adjusted based on Table 1 of Interim NZEB Specification.
    - For activities where the Lumens/ circuit watt can be entered directly into SBEM, the assessor should enter the value directly into SBEM. ie it should account for the value from Table 1 of the Interim NZEB Specification (65 lumen/ watt) divided by the maintenance factor from Table 1 of the Interim NZEB Specification (0.8)

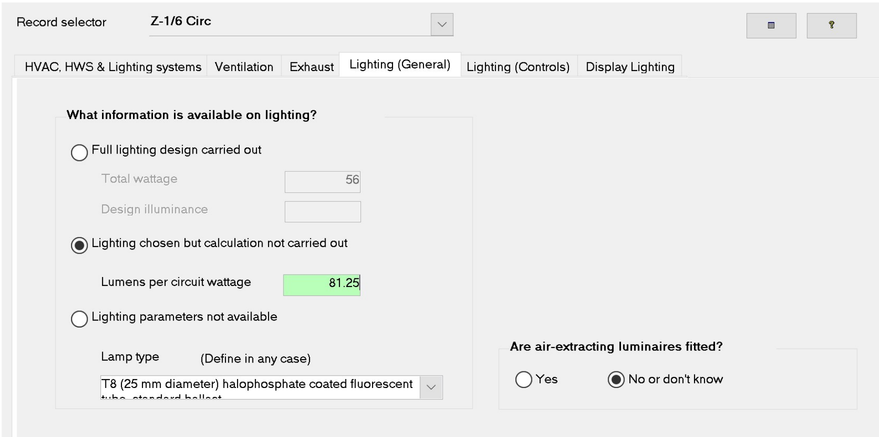

Figure 12 Entry of Lumen/ circuit watt for reference building

- For activities where the Lumens/ circuit watt cannot be entered directly into SBEM, the assessor should use the following equation to determine the power density of the lighting:

$$\text{Power density per 100 lux} = [(1.93 + 0.007xR + 0.063xR^2)/ MF] \times 60/65$$

Where R is the ratio of walls in the zone to floor area and MF is the maintenance factor.

In the NZEB Interim Spec Tool, SEAI have developed a calculation tool to assist with the calculation. In the "Lighting" tab enter the zone name, wall area and floor area of the zone along with the Design Illuminance, if unknown use default from SBEM. For example, refer to Figure 13, an office with a floor area of 179.4m2 and wall area of 351m2. Using the default design illuminance for offices the tool calculates the wattage for the zone as 2261 Watts.

Zone Name	Wall Area of Zone m2	Floor Area of Zone, m m2	R	Power Density w/m2/100 lux	Design Illuminance lux	Total Wattage Watts
Z1/10 Office	351	179.4	1.96	2.52	500	2261.33

Figure 13 Tool for calculating the Wattage of Reference Building

This is then entered into SBEM, refer to figure 14 as follows:

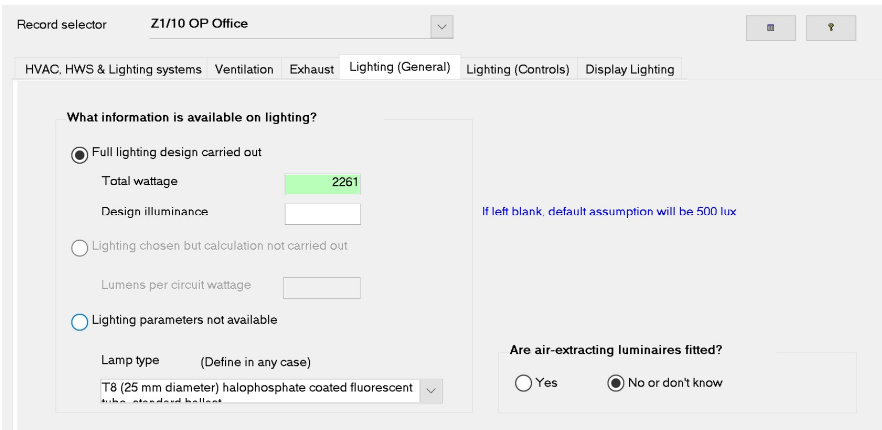

Figure 14 Entry of full lighting design for reference building

- Lighting Controls should be adjusted based on Table 1 of Interim NZEB Specification and should be entered into SBEM as follows:

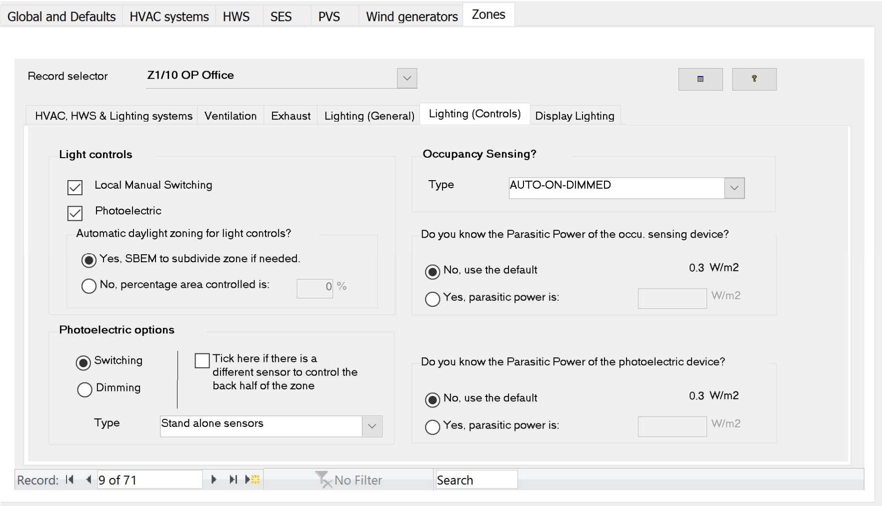

Figure 15 Entry of Lighting Controls for reference building

2.6 Renewables

- The reference building entered into SBEM V3.5b should **exclude** renewable energy, as the tool will calculate the renewable energy ratio of 20%.

3 Actual Building

The actual building is entered into the SBEM V3.5b software. Note that for Lighting, the selection of "Lighting Parameters Not Available" does not correctly account for the maintenance factor and therefore should not be used.

Where lighting parameters are not available, designers should develop a specification of the lighting based on the Lumen / circuit watt or power density (W/m2/100 lux).

4 Interim NZEB Performance Specification Tool

There are a number of sections in the tool as follows:

- **General Information and Assessor Details**
  - Identify the public body and applicable building.
  - Identify the BER Assessor name and number.
- **Reference Building**
  - Enter the energy associated with the reference building.
- **Actual Building**
  - Enter the energy associated with the actual building
  - Enter details associated with renewable technologies
- **Results**
  - The calculation tool automatically calculates the Energy Performance Coefficient (EPC), Carbon Performance Coefficient (CPC) and Renewable Energy Ratio (RER).

4.1 Reference Building

The assessor completes the SBEM model for the reference building based on Section 2 and takes the delivered energy figures for the Actual building from the SBEM software. Figure 16 shows where the data is taken from the results page in SBEM.

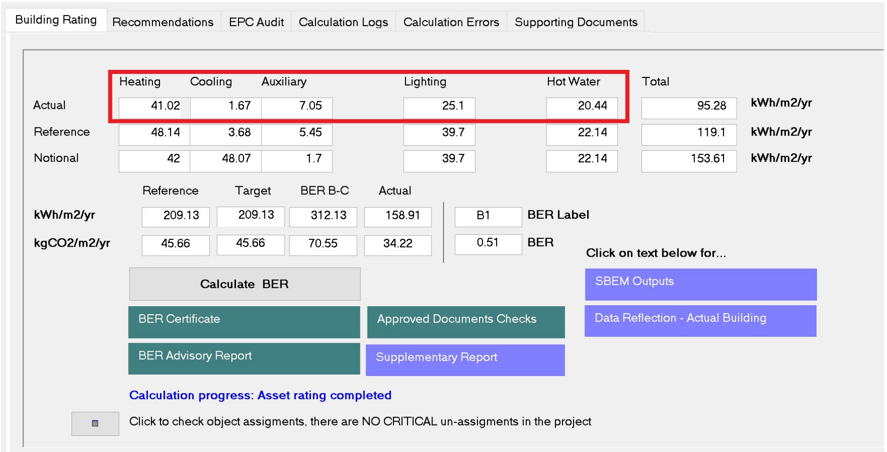

Figure 16 Data taken from SBEM

The assessor completes this data in the tool, refer to Figure 17.

3. Reference Building Data

	Actual Energy Use:		Guidance Note:	Fuel:	Primary Energy:	CO2 Emissions:
Heating Energy	41.02	kWh/m2/yr	Values are taken from the actual energy use for the manually created Reference Building	Mains Gas	45.12	8.33
Cooling Energy	1.67	kWh/m2/yr		Electricity	3.66	0.79
Auxiliary Energy	7.05	kWh/m2/yr		Electricity	15.44	3.33
Lighting Energy	25.1	kWh/m2/yr		Electricity	54.97	11.87
Hot Water Energy	20.44	kWh/m2/yr		Mains Gas	22.48	4.15
			Reference Building without Renewable Contribution		141.67	28.47

Figure 17 Data entered under Section 3 Reference Building Data

The tool calculates the Primary Energy Use and Carbon Performance of the reference building using current primary energy factors without a renewable contribution.

The tool then calculates the area of photovoltaics required to meet the 20% renewable energy ratio. Based on achieving the 20% RER, the tool calculates the actual Reference Building Primary Energy Use and Reference Building Carbon Emissions.

Renewable Energy Ratio	20%	
Epren Primary Renewable Energy required to meet RER	28.33	kWh/m2/yr
Area of Building	6332	m2
Estimated apeture area of photovoltaic (based on south facing panels at 30 degree angle with no overshading)	676.78	m2
Reference Building Primary Energy Use	**113.34**	**kWh/m2/yr**
Reference Building Carbon Emissions	**22.35**	**kgCO2/m2/yr**

Figure 18 Reference Building Primary Energy Use and Carbon Emissions

4.2 Actual Building

The assessor completes the SBEM model for the actual building and takes the delivered energy figures for the Actual building from the SBEM software, refer to Figure 19 and enters them into the tool, refer to Figure 20.

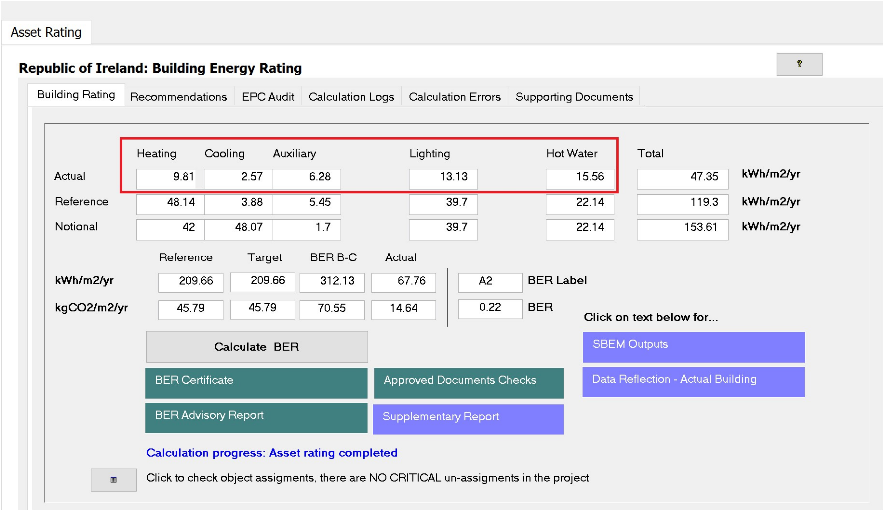

Figure 19 Data taken from SBEM for Actual Building

The assessor then selects which fuels are relevant based on the tool.

4. Actual Building Data						
	Actual Energy Use:		Guidance Note:	Fuel:	Primary Energy:	CO2 Emissions:
Heating Energy	9.81	kWh/m2/yr	Values are taken from the actual energy use for the Actual Building	Mains Gas	10.79	1.99
Cooling Energy	2.57	kWh/m2/yr		Electricity	5.63	1.22
Auxiliary Energy	6.28	kWh/m2/yr		Electricity	13.75	2.97
Lighting Energy	13.13	kWh/m2/yr		Electricity	28.75	6.21
Hot Water Energy	15.56	kWh/m2/yr		Mains Gas	17.12	3.16
Alternate Fuel	0	kWh/m2/yr		Electricity	0.00	0.00
					76.04	15.55

Figure 20 Data entered under Section 4 Actual building data

Where more than one fuel is being used to provide heating/ cooling the "Alternate Fuel" can be used.

For example, the majority of a building is heated using gas boilers, however for a number of zones where a Split Air Conditioning system is present where heating is by means of Electric Heat Pumps.

Taking the example above in Figure 20, not all of the 9.81 kWh/m2/yr is by means of gas heating. Therefore, the assessor will need to refer to the technical output report (Filename_sim.csv). This can be opened in Microsoft Excel and is accessible from the project folder. The technical output report will give details of the energy associated with each use but also give details of the fuel usage.

REPORT- Energy consumption by Fuel Type (kWh/m2): PROJECT													
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6332.1	NatGas	LPG	BioGas	Oil	Coal	Anthracite	Smokeless	DuelFuel	Biomass	GridSupEle	WasteHeat	DH	All
Month	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2
JAN	2.95137	0	0	0	0	0	0	0	0	2.25568	0	0	5.20706
FEB	2.69279	0	0	0	0	0	0	0	0	1.96871	0	0	4.6615
MAR	2.3902	0	0	0	0	0	0	0	0	2.01473	0	0	4.40494
APR	1.75714	0	0	0	0	0	0	0	0	1.70293	0	0	3.46007
MAY	1.42712	0	0	0	0	0	0	0	0	1.83009	0	0	3.2572
JUN	1.32081	0	0	0	0	0	0	0	0	1.79711	0	0	3.11793
JUL	1.3538	0	0	0	0	0	0	0	0	1.88991	0	0	3.24371
AUG	1.36689	0	0	0	0	0	0	0	0	1.86077	0	0	3.22766
SEP	1.34537	0	0	0	0	0	0	0	0	1.74092	0	0	3.08629
OCT	1.94299	0	0	0	0	0	0	0	0	2.06628	0	0	4.00927
NOV	2.56436	0	0	0	0	0	0	0	0	2.15853	0	0	4.72289
DEC	2.89801	0	0	0	0	0	0	0	0	2.05172	0	0	4.94973
SUM	24.0108	0	0	0	0	0	0	0	0	23.3374	0	0	47.3482
KG CO2/m:	4.8742	0	0	0	0	0	0	0	0	15.006	0	0	19.8802

Figure 21 Technical Output Report

The technical output report shows that 24.01 kWh/m2/yr is from Natural Gas. All of the hot water is from Natural Gas, therefore the heating from Natural Gas is 24.01 – 15.56 = 8.45 kWh/m2/yr. Therefore, to enter this in the tool 8.45 kWh/m2 as gas and 1.36 kWh/m2 as an alternate fuel, as per Figure 22.

4. Actual Building Data						
	Actual Energy Use:		Guidance Note:	Fuel:	Primary Energy:	CO2 Emissions:
Heating Energy	8.45	kWh/m2/yr	Values are taken from the actual energy use for the Actual Building	Mains Gas	9.30	1.72
Cooling Energy	2.57	kWh/m2/yr		Electricity	5.63	1.22
Auxiliary Energy	6.28	kWh/m2/yr		Electricity	13.75	2.97
Lighting Energy	13.13	kWh/m2/yr		Electricity	28.75	6.21
Hot Water Energy	15.56	kWh/m2/yr		Mains Gas	17.12	3.16
Alternate Fuel	1.36	kWh/m2/yr		Electricity	2.98	0.64
					77.53	15.91

Figure 22 Data entered under Section 4 Actual building data for Alternate Fuel

The assessor then selects which renewable technologies are on site.

	Installed Renewable Energy
Photovoltaic	No
Wind Energy	No
Solar Panel	No
Biomass/ Biogas	No
Combined Heat and Power	Yes
Heat Pump Technology	No

Figure 23 Renewable Selection

4.2.1 Photovoltaics

Where photovoltaics' are present in the actual building, the assessor should complete the "Photovoltaic" section in the tool.

The technical output report (Filename_sim.csv) can be opened in Microsoft Excel, it is accessible from the project folder.

Within the file, a summary of the LZC technologies is provided. The assessor should take the kWh/m2 for the PVs directly from the technical output report and enter into the tool.

20	REPORT- LZC. Energy Produced by LZC technologies						
21	--						
22		PVS	Wind	CHP	TOTAL		SES
23	kWh/m2	7.21934	0	0	7.21934	MJ/m2	0

Figure 24: Data taken from Technical Output Report

The assessor should also confirm what percentage of the power from the photovoltaic is used on site.

Photovoltaic					
	Energy Contribution taken from XXX_sim file			Primary Energy Factor	CO2 Emissions
Photovoltaic	7.22	kWh/m2/yr	Photovoltaic Used on Site	2.19	0.473
% of Photovoltaic used on site	100%		Photovoltaic Exported Off Site	2.19	0.473
Primary Energy from Photovoltaic	15.81	kWh/m2/yr			
Carbon Emissions from Photovoltaic	3.42	kgCO2/m2/yr			

Figure 25: Data entered into tool

The tool then calculates the primary energy and carbon emissions from the photovoltaics.

4.2.2 Wind Turbine

Similarly, where wind turbines are present in the actual building, the assessor should complete the "Wind Turbine" section in the tool.

The technical output report (Filename_sim.csv) can be opened in Microsoft Excel, it is accessible from the project folder.

Within the file, a summary of the LZC technologies is provided. The assessor should take the kWh/m2 for the Wind directly from the technical output report and enter into the tool.

20	REPORT- LZC. Energy Produced by LZC technologies							
21	--							
22		PVS	Wind	CHP	TOTAL			SES
23	kWh/m2	0	4.64203	0	4.64203		MJ/m2	0

Figure 26: Data taken from Technical Output Report

The assessor should also confirm what percentage of the power from the photovoltaic is used on site.

Wind Energy					
	Energy Contribution taken from XXX_sim file			Primary Energy Factor	CO2 Emissions
Wind Energy	4.64	kWh/m2/yr	Wind Energy Used on Site	2.19	0.473
% of Wind Energy used on site	100%		Wind Energy Exported Off Site	2.19	0.473
Primary Energy from Photovoltaic	10.16	kWh/m2/yr			
Carbon Emissions from Photovoltaic	2.19	kgCO2/m2/yr			

Figure 27: Data entered into tool

The tool then calculates the primary energy and carbon emissions from the wind turbines.

4.2.3 Solar Panel

Where solar panels are present in the actual building, the assessor should complete the "Solar Panel" section in the tool.

The technical output report (Filename_sim.csv) can be opened in Microsoft Excel, it is accessible from the project folder.

Within the file, a summary of the LZC technologies is provided. The assessor should take the MJ/m2 for the Solar (SES) directly from the technical output report and enter into the tool.

REPORT- LZC. Energy Produced by LZC technologies							
--							
	PVS	Wind	CHP	TOTAL			SES
kWh/m2	0	0	0	0		MJ/m2	6.2842

Figure 28: Data taken from Technical Output Report

The assessor should also confirm the seasonal efficiency of the heat source as entered in SBEM.

Solar Panel					
	Energy Contribution taken from XXX_sim file			Primary Energy Factor	CO2 Emissions
SES	5.59	MJ/m2	Solar Panel	1.1	0.203
Seasonal Efficiency of Heat Source	91%				
Primary Energy from Solar Panels	1.88	kWh/m2/yr			
Carbon Emissions from Solar Panels	0.35	kgCO2/m2/yr			

Figure 29 Data entered into tool

The tool then calculates the primary energy and carbon emissions from the solar panels.

4.2.4 Biomass

Where heating or hot water is provided by biomass or biogas, the assessor should calculate building energy consumption based on the overall efficiency of the heating system.

In the tool, the assessor should then enter the percentage of heating and/or provided by the biomass boiler.

For example, the heat demand for a building is 100kWh, a biomass boiler provides 60% of the heat demand with an efficiency of 75%, while a gas boiler provided the remainder of the heat demand with an efficiency of 91%.

	Heat Demand provided by boiler kWh/m2/yr	Seasonal Efficiency	Delivered Energy	% of Delivered Energy
Biomass Boiler	60	75%	80.0	64.5%
Gas Boiler	40	91%	43.96	35.5%
Combined	100	80.7%	123.96	

The combined efficiency of the boiler is entered into SBEM as 80.7%.

While in the tool the % of Delivered Energy is 64.5% for Biomass boiler.

The combined efficiency and % of Delivered Energy should be based on the design of the system and should be signed off by a suitably qualified person.

Biomass/ Biogas							
	Based on Design Calculation		Guidance Note:				
% of Delivered Heating provided by Biomass/ Biogas	64.6%		Refer to Guidance			Primary Energy Factor	CO2 Emissions
% of Delivered Hot Water provided by Biomass/ Biogas	64.6%		Document for	Biomass/ Biogas		1.1	0.025
Fuel of Other System	Mains Gas		calculation of %	Mains Gas		1.1	0.203
Primary Energy from Biomass	88.09	kWh/m2/yr		Primary Energy Use from Htg & DHW	136.36	kWh/m2/yr	
Carbon Emissions from Biomass	2.00	kgCO2/m2/yr		CO2 from Htg & DHW	10.91	kgCO2/m2/yr	

Figure 30: Data entered into tool

4.2.5 Combined Heat and Power

Where combined heat and power are present in the actual building, the assessor should complete the "Combined Heat and Power" section in the tool.

The technical output report (Filename_sim.csv) can be opened in Microsoft Excel, it is accessible from the project folder.

Within the file, the assessor should go to the Energy consumption by End Uses (kWh/m2) and take the CHP_All kWh/m2 directly from the technical output report and enter into the tool.

101	REPORT- Energy consumption by End Uses (kWh/m2):													
102	---													
103	6332.1	Heating	Cooling	Aux Energy	Lighting	Hot Water	All	Equipment	All+Equipment	CHP_Heat	CHP_Cool	CHP_HW	CHP_All	All+CHP_All
104	Month	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2	kWh/m2
105														
106	JAN	0.932882	0.173423	0.545772	1.28072	0.916285	3.84908	5.87655	9.72563	1.60102	0	0.866449	2.46747	6.31655
107	FEB	0.843294	0.160675	0.495989	1.09004	0.842236	3.43223	5.32899	8.76122	1.44767	0	0.78768	4.70281	8.13504
108	MAR	0.598369	0.194054	0.545772	1.12702	0.916285	3.3815	5.87655	9.25805	1.02763	0	0.866449	6.59689	9.97839
109	APR	0.319033	0.211944	0.474321	0.931975	0.839028	2.7763	5.31208	8.08838	0.547649	0	0.748295	7.89283	10.6691
110	MAY	0.086521	0.255992	0.522263	1.00736	0.893751	2.76589	5.71286	8.47875	0.147596	0	0.827061	8.86749	11.6334
111	JUN	0.015721	0.27214	0.52134	1.00362	0.884089	2.69692	5.63947	8.33639	0.027166	0	0.827061	9.72172	12.4186
112	JUL	0.006215	0.294141	0.545772	1.05	0.916285	2.81241	5.87655	8.68896	0.010739	0	0.866449	10.5989	13.4113
113	AUG	0.012761	0.263345	0.545772	1.05165	0.916285	2.78981	5.87655	8.66636	0.022051	0	0.866449	11.4874	14.2772
114	SEP	0.069363	0.207314	0.497832	0.995859	0.861561	2.63193	5.47578	8.10771	0.118143	0	0.78768	12.3932	15.0252
115	OCT	0.329625	0.192377	0.56928	1.20419	0.938812	3.23429	6.04024	9.27453	0.565274	0	0.905831	13.8643	17.0986
116	NOV	0.717012	0.171182	0.544851	1.24065	0.906622	3.58032	5.80316	9.38348	1.23032	0	0.866449	15.9611	19.5414
117	DEC	0.971836	0.173527	0.475244	1.14436	0.848692	3.61366	5.38546	8.99912	1.66821	0	0.748295	18.3776	21.9913
118														
119	SUM	4.90262	2.57011	6.2842	13.1275	10.6799	37.5643	68.2042	105.769	8.41346	0	9.96415	18.3776	55.942

Figure 31 Data taken from Technical Output Report

The assessor should also confirm the thermal and electrical efficiency of the CHP as well as the CHP fuel.

Combined Heat and Power					
	Energy Contribution taken from XXX_sim file				
CHP_All	18.38	kWh/m2	Heating and Hot Water	9.19	kWh/m2
Electrical Efficiency of CHP	30%		Electrical	5.51	kWh/m2
Thermal Efficiency of CHP	50%				
CHP Fuel	Mains Gas			Primary Energy Factor	CO2 Emissions
Renewable Primary Energy from Heat Pump	3.61	kWh/m2/yr	Electricity	2.19	0.473
			Mains Gas	1.1	0.203

Figure 32 Data entered into tool

The tool then calculates the primary energy of the renewable element of the CHP.

4.2.6 Heat Pump

The assessor confirms if a Heat Pump provided heating and hot water and confirms the efficiency of the heat pump as entered into SBEM.

Where the heat pump provides 100% of the heating and/ or hot water the efficiency entered in SBEM and the tool should be as per the relevant standards.

However, where the heat pump is providing only a percentage of the heat source, for example a radiator system served by heat pump and gas boiler, the assessor is required to carry out a Bivalent calculation.

The seasonal efficiency entered into SBEM is calculated as follows:

$$SEff_{equivalent} = \frac{\underline{\text{Primary Energy Factor}_{Elec}}}{(\underline{\text{Primary Energy Factor}_{Elec}} / COP_{heatpump} \times \%\ Load_{HeatPump}) + (\text{Primary Energy Factor}_{gas} / SEff_{boiler} \times \%\ Load_{boiler})}$$

Therefore, for a heat pump with COP of 450% providing 50% of the load and a gas boiler of 91% providing 50% of the load the $SEff_{equivalent}$ is equal to:

$$2.19 / [(2.19/450\% \times 50\%) + (1.1/91\% \times 50\%)] = 258\%$$

This can be verified in the tool, where the bivalent efficiency is calculated for the heating and hot water:

Heat Pump					
	Based on Design Calculation			Primary Energy Factor	CO2 Emissions
% of Heating provided by Heat Pump	50%		Electricity	2.19	0.473
Efficiency of Heat Pump for Heating	450%		Mains Gas	1.1	0.203
% of Hot Water provided by Heat Pump	100%		Bivalent Seasonal Efficiency for Heating	258%	
Efficiency of Heat Pump for Hot Water	200%		Bivalent Seasonal Efficiency for Hot Water	200%	
Fuel of Other System	Mains Gas		Heating from Heat Pump	0.57	kWh/m2
Seasonal Efficiency of Heat Source	91%		Hot Water from Heat Pump	5.73	kWh/m2

Figure 33 Bivalent Calculation in NZEB Tool

This is then entered into SBEM as 2.58 with the fuel source of "Grid Supplied Electricity" as follows:

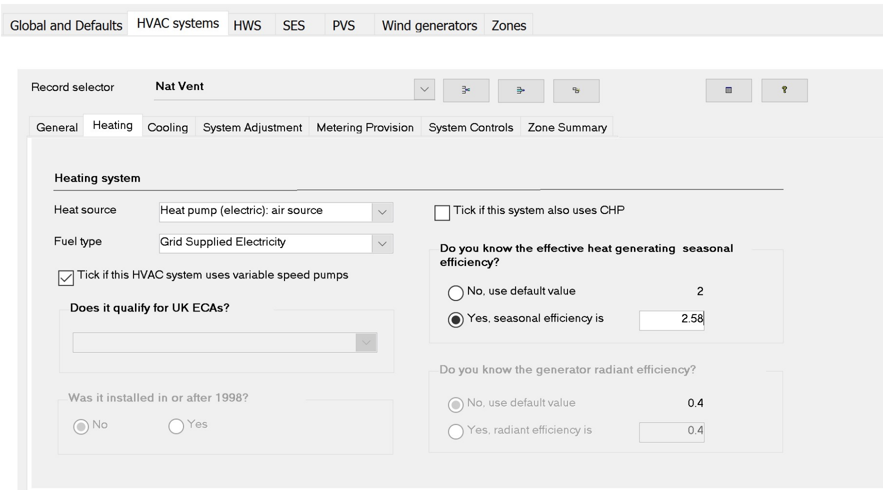

Figure 34 Bivalent Entry in SBEM

The tool then calculates the primary energy of the renewable element of the Heat Pump.

Heat Pump					
	Based on Design Calculation			Primary Energy Factor	CO2 Emissions
% of Heating provided by Heat Pump	50%		Electricity	2.19	0.473
Efficiency of Heat Pump for Heating	450%		Mains Gas	1.1	0.203
% of Hot Water provided by Heat Pump	100%		Bivalent Seasonal Efficiency for Heating	258%	
Efficiency of Heat Pump for Hot Water	200%		Bivalent Seasonal Efficiency for Hot Water	200%	
Fuel of Other System	Mains Gas		Heating from Heat Pump	0.57	kWh/m2
Seasonal Efficiency of Heat Source	91%		Hot Water from Heat Pump	5.73	kWh/m2
Renewable Primary Energy from Heat Pump	2.05	kWh/m2/yr			

Figure 35 Data entered into tool

The tool then calculates the primary energy of the renewable element of the Heat Pump.

4.2.7 Actual Building Energy and Renewable

The tool then calculates the Renewable Primary Energy Epren, the Total Primary Energy Eptot, the Actual Building Primary Energy Use and the Actual Building Carbon Emissions

			Results from SBEM		58.28	12.27
	Installed Renewable Energy		Renewable Primary Energy	Adjustment to Eptot	Adjustment to Actual Primary Energy Use	Adjustment to Actual CO2 Emissions
Photovoltaic	Yes		4.38	Accounted for in figures from SBEM	-4.38	-0.95
Wind Energy	No		0.00	Accounted for in figures from SBEM	0.00	0.00
Solar Panel	No		0.00	0.00	Accounted for in figures from SBEM	
Biomass/ Biogas	Yes		10.14	Accounted for in figures from SBEM		
Combined Heat and Power	No		0.00	0.00	0.00	0.00
Heat Pump Technology	No		0.00	Accounted for in figures from SBEM		
			Guidance Note:			
Renewable Primary Energy Epren	14.52	kWh/m2/yr	Complete appropriate sections			
Total Primary Energy Eptot	58.28	kWh/m2/yr				
Actual Building Primary Energy Use	53.90	kWh/m2/yr				
Actual Building Carbon Emissions	11.32	kgCO2/m2/yr				

Figure 36: Results from Tool

4.3 Results

The tool finally calculates the EPC/ CPC and RER, highlighting where the building is not compliant with the following requirements:

	Option 1	Option 2
Maximum Permitted Energy Performance Coefficient	1.0	0.9
Maximum Permitted Carbon Performance Coefficient	1.15	1.04
Minimum Renewable Energy Ratio	20%	10%

EPC	**0.49**	Compliant
CPC	**0.40**	Compliant
RER	**0.33**	Compliant

Figure 37 Compliant Building

EPC	**1.16**	Non Compliant
CPC	**1.16**	Non Compliant
RER	**0.25**	Compliant

Figure 38 Non Compliant Building