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# Interim NZEB Performance Specification Calculation Methodology

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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.

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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 31<sup>ST</sup> 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 1<sup>st</sup> 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 1<sup>st</sup> 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 1<sup>st</sup> 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.

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- 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.

EPC = <u>Primary Energy of Actual Building</u>

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.

CPC = <u>Primary Carbon Dioxide emissions of Actual Building</u>

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.

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Geometrical detail for the w	nole Project					
General & geometry Globa	I Thermal Bridges					
Junctions involving metal	cladding		Junctions NOT involving met	al cladding		
Type of Junction	User Psi		Type of Junction	User Psi	Accredite	ed
	W/mK	W/mK		W/mK	detail?	W/mK
Roof-wall	0.28	0.28	Roof-wall		$\checkmark$	0.12
Wall-ground floor	1	1	Wall-ground floor			0.16
Wall-wall (corner)	0.2	0.2	Wall-wall (corner)			0.09
Wall-floor (not ground floo	r) 0	0	Wall-floor (not ground floor)			0.07
Lintel above window or do	or 1	1	Lintel above window or door			0.3
Sill below window	0.95	0.95	Sill below window			0.04
Jamb at window or door	0.95	0.95	Jamb at window or door			0.05
					Tic	k all

#### **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.

al & geometry Global Thermal Bridges	
Building infiltration (Global)	Building details
No, use default value 10 m3/h/m2	Zone height (Global) 3.6
Yes, Air permeability at 50pa is     m3/h/m2	Building area:
	m2
Building orientation	Building volume
Building (clockwise) rotation 0 v ees	Let iSBEM calculate the volume of the building
	O Use my own value
Section 6 (Scotland). Accredited Construction Details	
Tick when building designed and built following Accredited Construction Details. (These details are primarily of use for domestic type construction)	

#### Figure 2: Building Infiltration

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

Infiltration		Thermal Bridges
No, use default value Yes, Air permeability at 50pa is	10 m3/h/m2 G 3 m3/h/m2	✓ Tick here to use Global Psi values

**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.

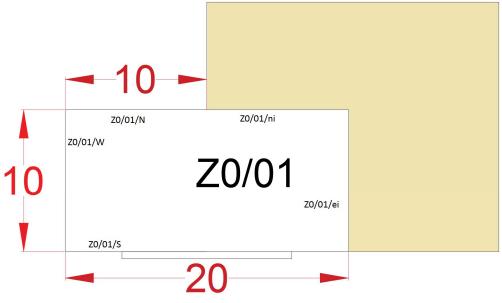


Figure 4 Window Example

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.

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Heating system	n			
Heat source	LTHW boiler	$\sim$	Tick if this system also uses CHP	
Fuel type	Natural Gas	~	Do you know the effective heat gen efficiency?	erating seasonal
	HVAC system uses variable speed pum	ps	○ No, use default value	0.89
Does it qua	lify for UK ECAs?		Yes, seasonal efficiency is	0.91
ECA list (afte	er 2001)	$\sim$		
			Do you know the generator radiant	efficiency?
Was it instal	led in or after 1998?		No, use default value	0.4
● No	OYes		Yes, radiant efficiency is	0.4

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.

H	HVAC Systems Performance											
Svs	stem Type	Heat dem	Cool dem	Heat con	Cool con	Aux con	Heat	Cool	Heat gen	Cool gen		
U Uy	iem rype	MJ/m2	MJ/m2	kWh/m2	kWh/m2	kWh/m2	SSEEF	SSEER	SEFF	SEER		
[ST	] Active chi	lled beams	, [HS] LTHV	V boiler, [Hl	FT] Natural	Gas, [CFT]	Grid Suppl	ied Electric	ity			
	Actual						0.70	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.

Record se	elector FCL				~	34	Ð	9				8
General	Heating Cooli	ig System A	Adjustment	Metering	Provision 8	System Co	ontrols	Zone Summ	nary			
	Name	Refere	ence Buildir	na								
				.9								
	Туре		chilled bea					~				
	Type Heating system	Active	chilled bea				Ventilati Heat re	on				
	Туре	Active	chilled bea			× ×	Heat re	on			~	
	Type Heating system Heat source	Active LTHW Natura	chilled bea boiler		ses CHP	~	Heat re No hea	on covery t recovery	Heat Rec. s	easonal ef		
	Type Heating system Heat source	Active LTHW Natura	chilled bea boiler	ims	ses CHP	~	Heat re No hea Do yo	on covery t recovery		easonal ef		ratio
	Type Heating system Heat source Fuel type	Active LTHW Natura	chilled bea boiler	ims	ses CHP	~	Heat re No hea Do yo	on covery t recovery u know the o, use the de			ficiency?	ratio

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

	eference Building	→ 3e 9e 9e	<b>T</b>
neral Heating Coo	ling System Adjustment Metering Pr	rovision System Controls Zone Summary	
Cooling system			
Pack chiller	Default chiller	Do you know the generator ratio (SEER)?	seasonal energy efficiency
Generator type	Air cooled chiller	No, use default value	2
Generator kW	Up to 100kW	$\sim$	
	Grid Supplied Electricity	Yes, seasonal EER is:	4.5
Fuel type			
Fuel type	r UK ECAs?		
		Do you know the generator ratio (EER)?	nominal energy efficiency

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

al and Defaults	HVAC systems	5 HWS	SES	PVS	Wind g	jenerators	Zones		
Record selector	Reference	Building				→ 3*	₽	ф	E ?
General Heatin	g Cooling Sy	stem Adjus	stment	Metering	Provision	System Co	ontrols Zo	one Summary	
Ductwork and	AHU leakage		ratio	0.08		Specific Fa	in Power f	or the system	
O No. use	work been leaka default leakage eets next CEN cla	-		~		O No, u	now the Sp se the defa SFP for the		1.8 W/l/s
Does the AH	U meet CEN lea	kage stan	dards?			Auxiliary E	nergy for f	anned warm a	ir heaters
O No, use o	lefault leakage					Do you k	now the k\	Wh aux.energy	/kWh heating?
Yes, it m	eets next CEN cla	ssification:				No, u	se the defa	ult	0.02
Class L3				$\sim$		O Yes.	kWh/kWh:		ratio

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

Global and Defaults	HVAC systems HWS SES PVS	S Wind generators Zo	nes	
Record selector	Reference Building		₿• ₽	E ?
General Heating	Cooling System Adjustment Meteri	ng Provision System Control	s Zone Summary	
- <b>is</b> ((	tering provision this HVAC system separately sub-mete No or don't know Yes, it is RT with alarm for "out of range" values? No or don't know Yes, it does			

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

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- 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.

HWS selector	Basic HV	/S		* *	цу.	*
General Sto	orage & Secondary	circulation Assigned				
	Name	Basic HWS				
	Generator type	Dedicated hot water boiler		$\sim$		
		Tick if the generator is later	than 1998			
	Fuel type	Natural Gas		$\sim$		
	Do you know the	effective heat generating seasor	al efficiency?			
	O No, use de	ault value	0.65			
	Yes, seaso	nal efficiency is	0.91			

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)

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Record selector	Z-1/6 Cire	•		~			
HVAC, HWS & Lighti	ng systems	Ventilation	Exhaust	Lighting (General)	Lighting (Controls)	Display Lighting	
What inform	ation is ava	ilable on lig	hting?				
Full light	ing design c	arried out					
Total v	vattage			56			
Design	illuminance						
Lighting	chosen but o	calculation no	t carried ou	t			
Lumen	s per circuit	wattage	81.	25			
	parameters	not available					
Lamp t	ype (I	Define in any	case)			acting luminaires fitted?	
	mm diamete		hate coated	fluorescent 🗸	⊖ Yes	No or don't know	

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

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	Floor Area of Zone, m	R	Power Density	Design Illuminance	Total Wattage
	m2	m2		w/m2/100 lux	lux	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:

Record selector	Z1/10 OP	Office		$\checkmark$			۴ (D
HVAC, HWS & Lighti	ng systems	Ventilation	Exhaust	Lighting (General)	Lighting (Controls)	Display Lighting	
What inform		-	hting?				
Total w	vattage		22	261			
Design	illuminance				lf left blank, defau	It assumption will be	• 500 lux
	chosen but ci	alculation no	t carried ou	ıt			
Lumen	s per circuit v	vattage					
Clighting	parameters n	ot available					
Lampt	ype (D	efine in any o	case)		Are air-extr	acting luminaires f	itted?
	mm diamete		hate coated	d fluorescent	⊖ Yes	No or don't	know

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:

Record selector Z1/10 OP Office	м т.				
HVAC, HWS & Lighting systems Ventilation Exhaust Lighting (Gene	eral) Lighting (Controls) Display Lighting				
Light controls	Occupancy Sensing?				
Local Manual Switching     Photoelectric	Type AUTO-ON-DIMMED V				
Automatic daylight zoning for light controls?	Do you know the Parasitic Power of the occu. sensing device?				
Yes, SBEM to subdivide zone if needed.	No, use the default     0.3 W/m2				
O No, percentage area controlled is: 0 %	Yes, parasitic power is; W/m2				
Photoelectric options					
Switching  Tick here if there is a different sensor to control the back half of the zone	Do you know the Parasitic Power of the photoelectric device?				
Dimming back half of the zone	No, use the default     0.3 W/m2				
Type Stand alone sensors 🗸	Yes, parasitic power is: W/m2				

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
  - o Enter the energy associated with the actual building
  - o 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.

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	Heating C	Cooling Au	kiliary	Ligt	nting	ŀ	Hot Water	Total	
Actual	41.02	1.67	7.05		25.1		20.44	95.28	kWh/m2/yr
Reference	48.14	3.68	5.45		39.7		22.14	119.1	kWh/m2/yr
Notional	42	48.07	1.7		39.7		22.14	153.61	kWh/m2/yr
	Reference	e Target	BER B-C	Actual					
kWh/m2/yr	209.13	3 209.13	312.13	158.91	E	1 BEF	R Label		
kgCO2/m2/yr	45.66	45.66	70.55	34.22	C	51 BEF	R Click o	n text below for	
		Calculate BER					SBEN	/ Outputs	
	BER Certif	BER Certificate				ts Checks	Data	Reflection - Actual Bu	ilding
	BER Advis	ory Report		Supplem	entary Rep	ort			

#### Figure 16 Data taken from SBEM

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

	Actual Energy Use:		Guid	lance Note:	Fuel:	Primary Energy:	CO2 Emissions:
Heating Energy		1.02 kWh/m	2/yr		Mains Gas	45.12	8.3
Cooling Energy		1.67 kWh/m	2/\ur	ues are taken from actual energy use	Electricity	3.66	0.79
Auxiliary Energy		7.05 kWh/m	/vr fc	or the manually	Electricity	15.44	3.33
Lighting Energy		25.1 kWh/m		created Reference Building	Electricity	54.97	11.87
Hot Water Energy		0.44 kWh/m	2/yr		Mains Gas	22.48	4.15
			Re	eference Building w Contribi		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		kgCO2/m2/yr

Figure 18 Reference Building Primary Energy Use and Carbon Emissions

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## 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.

uilding Rating	Recommendati	ons EPC Audit	Calcula	ation Logs	Calculatio	Errors	Supportin	g Documen	ts	
Γ	Heating C	Cooling Auxil	iary		Lighting		Hot	Water	Total	
Actual	9.81	2.57	6.28		13.1	3		15.56	47.35	kWh/m2/yr
Reference	48.14	3.88	5.45		39.	7		22.14	119.3	kWh/m2/yr
Notional	42	48.07	1.7		39.	7		22.14	153.61	kWh/m2/yr
	Reference	e Targel	BER B	-C Act	ual					
kWh/m2/yr	209.6	6 209.66	312.	13 6	7.76	A2	BER La	bel		
kgCO2/m2/yr	45.79	45.79	70.55	5 14	.64	0.22	BER	Click o	n text below for	
		Calculate BER						SBEM	Outputs	
	BER Certif	icate		Арр	roved Docu	ments C	hecks	Data F	Reflection - Actual Bu	uilding
	BER Advis	ory Report		Sup	plementary	Report				

#### 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			Mains Gas	10.79	1.9
Cooling Energy	2.57	kWh/m2/yr		Electricity	5.63	1.2
Auxiliary Energy	6.28	kWh/m2/yr	Values are taken from	Electricity	13.75	2.9
Lighting Energy	13.13	kWh/m2/yr	the actual energy use for the Actual Building		28.75	6.2
Hot Water Energy	15.56			Mains Gas	17.12	3.1
Alternate Fuel	ernate Fuel C			Electricity	0.00	0.0
					76.04	15.5

#### 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.

REFORT-E	neigy const	imption by	Fuerrype	KVV11/1112). 1	ROJECT								
6332.1	NatGas	LPG	BioGas	Oil	Coal	Anthracite	Smokeless	DuelFuel	Biomass	GridSupEle	WasteHea	tDH	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	C	0	0	0	0	0	(	2.25568	0	0	5.20706
FEB	2.69279	0	C	0	0	0	0	0	(	1.96871	0	0	4.6615
MAR	2.3902	0	C	0	0	0	0	0	(	2.01473	0	0	4.40494
APR	1.75714	0	C	0	0	0	0	0	(	1.70293	0	0	3.46007
MAY	1.42712	0	C	0	0	0	0	0	(	1.83009	0	0	3.2572
JUN	1.32081	0	C	0	0	0	0	0	(	1.79711	0	0	3.11793
JUL	1.3538	0	C	0	0	0	0	0	(	1.88991	0	0	3.24371
AUG	1.36689	0	C	0	0	0	0	0	(	1.86077	0	0	3.22766
SEP	1.34537	0	C	0	0	0	0	0	(	1.74092	0	0	3.08629
OCT	1.94299	0	C	0	0	0	0	0	(	2.06628	0	0	4.00927
NOV	2.56436	0	C	0	0	0	0	0	(	2.15853	0	0	4.72289
DEC	2.89801	0	C	0	0	0	0	0	(	2.05172	0	0	4.94973
SUM	24.0108	0	C	0	0	0	0	0	(	23.3374	0	0	47.3482
KG CO2/m	4.8742	0	C	) 0	0	0	0	0	(	15.006	0	0	19.8802

REPORT- Energy consumption by Fuel Type (kWh/m2): PROJECT

#### 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		Mains Gas	9.30	1.7.
Cooling Energy	2.57	kWh/m2/yr		Electricity	5.63	1.22
Auxiliary Energy	6.28	kWh/m2/yr	Values are taken from	Electricity	13.75	2.97
Lighting Energy	13.13		the actual energy use for the Actual Building		28.75	6.21
Hot Water Energy	15.56			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
No
No
No
No
Yes
Nc

#### 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.

21        FVS       Wind       CHP       TOTAL       SES         22       VVb/m2       7.21924       0       0       7.21924       M1/m2	20	REPORT- L	ZC. Energy F	roduced by	ologies			
	21							
22 kW/h/m2 7 21924 0 0 7 21924 MI/m2	22		PVS	Wind	CHP	TOTAL		SES
23 KWII/III2 7.21334 0 0 7.21334 IVIJ/III2	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	Photovolta	ic Used on Site	2.19	0.473
% of Photovoltaic used on site	100%		Photovoltaic Ex	ported 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.

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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	<b>REPORT-LZC.</b>	Enorm	Produced	hy ITC	tochnologies
20	NEFORI-LZC.	cheigy	Flouuceu	DY LZC	technologies

21							
22		PVS	Wind	СНР	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 Use	d on Site	2.19	0.47
% of Wind Energy used on site	100%		Wind Energy Exported	d Off Site	2.19	0.47
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- L	ZC. Energy I	Produced by	/ LZC techno	ologies		
	PVS	Wind	СНР	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.

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Solar Panel					
	Energy Contribution taken from XXX_sim file			Primary Energy Factor	CO2 Emissions
SES	5.59	MJ/m2	Solar Pane	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%	5	Refer to Guidance		Primary Energy Factor	CO2 Emissions
% of Delivered Hot Water provided by Biomass/ Biogas	64.6%	5	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	O2 from Htg & DHW 10.91	

#### 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.

102													
103 <b>6332</b> .	1 Heating	Cooling	Aux Energy	Lighting	Hot Water	All	Equipment	All+Equipment	CHP_Heat	CHP_Cool	CHP_HW	CHP_All	All+CHP_Al
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	C	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	c	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	C	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	C	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	C	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	C	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	C	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	C	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	C	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	C	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	C	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	C	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	C	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_AII	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 =

#### Primary Energy Factor<sub>Elec</sub>

(Primary Energy Factor<sub>Elec</sub> /COP heatpump x % Load HeatPump) + (Primary Energy Factor<sub>gas</sub>/ SEff boiler x % 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<sub>equivalent</sub> is equal to:

2.19 / [(2.19/450% × 50%) + (1.1/91% × 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			<b>Primary Energy Factor</b>	CO2 Emissions
% of Heating provided by Heat Pump	50%		Electricity	2.19	0.473
Efficiency of Heat Pump for Heating	450%		Mains Ga		0.203
% of Hot Water provided by Heat Pump	100%	<b>Bivalent Seasonal Efficie</b>	valent Seasonal Efficiency for Heating		
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 P	ump	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:

Global and Defaults	HVAC systems HWS SE	PVS Wind	generators Zones			
Record selector	Nat Vent		v 34 ∌ %	п ?		
General Heating	Cooling System Adjustmen	Metering Provision	System Controls Zone Summary			
Heating syste	m					
Heat source	Heat pump (electric): air so	urce 🗸	Tick if this system also uses C	HP		
Fuel type Grid Supplied Electricity V		$\checkmark$	Do you know the effective heat generating seasonal			
	HVAC system uses variable spee	d pumps	efficiency?	2		
	•	$\sim$	Yes, seasonal efficiency is	2.58		
			Do you know the generator rac	liant efficiency?		
	alled in or after 1998?		No. use default value	0.4		
No No	○ <sup>Yes</sup>		O Yes, radiant efficiency is	0.4		

#### 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

#### Q1 2018

			Results fr	om SBEM	58.28	12.2
	Installed Renewable Energy		Renewable Primary Energy	Adjustment to Eptot		
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 fi	gures from SBEM
Biomass/ Biogas	Yes		10.14	Accounted for in figures from SBEM		SBEM
Combined Heat and Power	No		0.00	0.00	0.00	0.00
Heat Pump Technology	No		0.00	Accou	inted for in figures from	SBEM
			Guidance Note:			
Renewable Primary Energy Epren	14.52	kWh/m2/yr				
Total Primary Energy Eptot	58.28	kWh/m2/yr	Complete			
Actual Building Primary Energy Use	53.90	kWh/m2/yr	appropriate sections			
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