Rugby Free Secondary School & Quest Academy

Sustainable Buildings Statement

19/01/2018

Document Ref: RFS-BMD-ZZ-XX-RP-M-38700

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CLIENT: BAM Construction

PROJECT: Rugby Free Secondary School & Quest Academy
Sustainable Buildings Statement

Contract no:

Job no: 4726/4757

Document Ref: RFS-BMD-ZZ-XX-RP-M-38700

Prepared by: D. Williams Checked by: D Burton

Date: 19/01/2018

Status: S2 - INFORMATION

Amendments				
Ref.	Date	Amendment	Amended by	Checked by
P01		First Issue	D. Williams	D. Burton

Introduction

The following statement sets out the energy and sustainable design strategy for the proposed Rugby Free Secondary School (RFSS) and the Quest Academy Rugby (QAR). This report will highlight the energy performance of the building and the "Be Lean" and "Be Clean" measures that have been adopted on the project to achieve Building Regulations compliance and to demonstrate compliance with Warwick District Council Planning requirement on integrating low/zero carbon technology into the development

For the Free school and Quest Academy the planning condition states the following:-

DP13 Renewable Energy Developments

B. In appropriate residential and non-residential developments, including conversions, the Council will require 10% of the predicted energy requirement to be produced on site, or in the locality from renewable energy resources

In line with the methodology set out within section 5 of the SPD we have initially considered the design to maximise energy efficiency of the installed systems i.e. high efficiency gas fired boilers etc. to compliment any renewable technology. Following the inclusion of energy efficiency measures it has been necessary to integrate renewable energy within the design to ultimately achieve the 10% reduction. Further to the feasibility appraisal set out below we are proposing to meet this requirement by integrating approximately 340m² (280m² for the free school and 60m² for the Academy) of roof mounted PV panels to generate a total of 47,474kWh of electricity per year mounted on the roof of the free school. Due to the design of the Academy it was agreed the requirement would be located on the roof of the free school.

Our approach to providing an energy efficient building in line with the above requirements has enabled the development of a solution, which we have tested using approved DCLG software, to demonstrate compliance with Approved Document L2A 2013

The calculated Approved document L2A:2013 carbon performance and emissions for the school are summarised below:

Rugby Free School

Summary	
Calculated CO_2 Emission Rate for the Notional building	20.0 Kg CO2/m2.annum
Target CO_2 Emission Rate (TER)	20.0 Kg CO_2/m².annum
Building CO_2 Emission Rate for the Actual building (BER)	16.7 Kg CO_2/m².annum
Improvement over notional building	16.5%
Status	**PASS**
Energy demand of the building (kWh/annum)	758,064 kWh
Energy demand delivered by energy efficiency measures (reduction)	36,672 kWh
Energy demand delivered by photovoltaic panels (kWh/annum)	41,880 kWh
Percentage of energy demand delivered by low carbon/renewable Energy	**10.36%**

Quest Academy Rugby

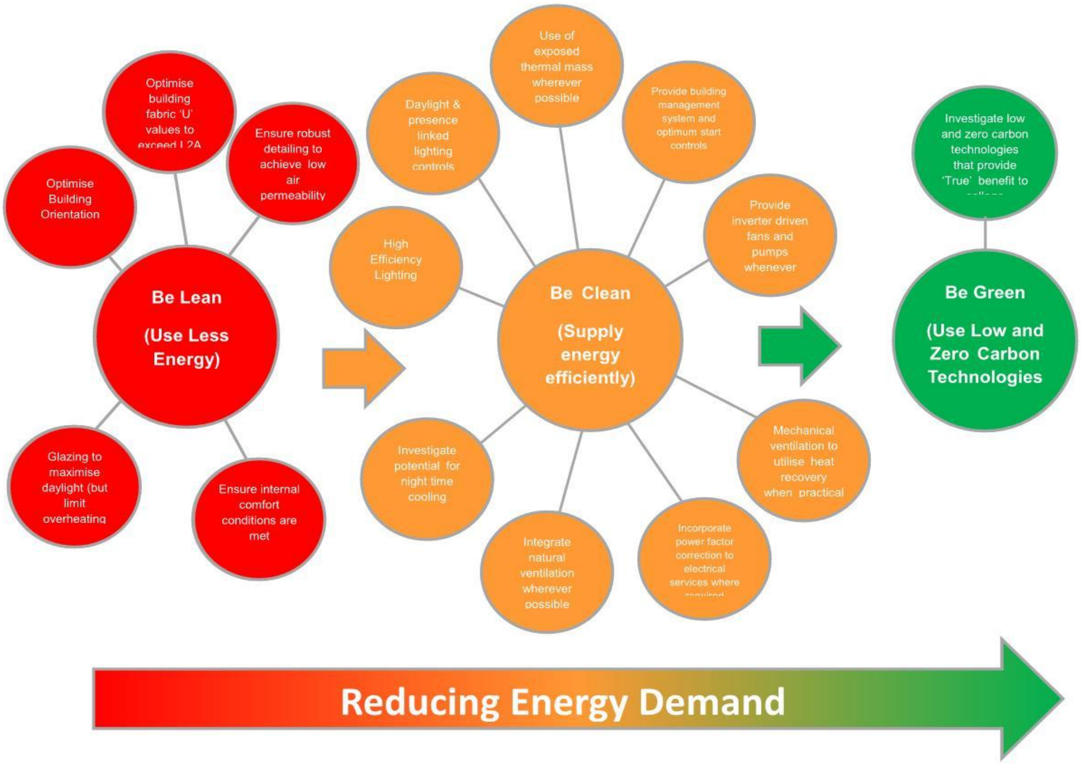
Summary	
Calculated CO_2 Emission Rate for the Notional building	22.5 Kg CO2/m2.annum
Target CO_2 Emission Rate (TER)	22.5 Kg CO_2/m².annum
Building CO_2 Emission Rate for the Actual building (BER)	19.5 Kg CO_2/m².annum
Improvement over notional building	13.3%
Status	**PASS**
Energy demand of the building (kWh/annum)	120,128.6 kWh
Energy demand delivered by energy efficiency measures (reduction)	3672 kWh
Energy demand delivered by photovoltaic panels (kWh/annum)	8859 kWh
Percentage of energy demand delivered by low carbon/renewable Energy	**10.43%**

Sustainable Design Strategy

For the RFSS and QAR, we have mapped out the sustainable design strategy that has been followed for the design of the building form, fabric and the environmental services to ensure a well-considered sustainable design solution is provided. This aims to maximise the energy efficiency of the building and thus reduces both carbon dioxide emissions and the energy demand and ultimately operating/running costs.

The strategy can be summarised below

- Be Lean - (Use Less Energy)
- Be Clean – (Supply Energy Efficiently)
- Be Green - (Use Renewables)



‘BE LEAN’ approach

The following section details the development of the building and the evidence of the key considerations undertaken to ensure we are designing a building that is ‘lean’

Optimise Building Orientation

The building orientation has been carefully considered to minimise heat gains whilst maximising daylight.

The building itself complies with the requirements of the EFSA’s Facilities Output Specification in relation to providing excellent levels of daylighting and to prevent overheating.

The EFSA Facilities Output Specification requirements are more onerous than the historical requirements to meet compliance and are provided to ensure an excellent learning environment for the pupils and staff.

With regards to daylighting — this building has been designed utilising climate based daylight modelling to ensure the rooms are well lit but also provide a good level of lighting uniformity across the whole room.

With regards to the internal environment a full overheating assessment has been completed utilising the new CIBSE TM52 Adaptive thermal comfort modelling

Air Permeability

A building with high air leakage increases the wastage of heat during the winter months and as defined within the building regulations a high leakage rate tends to mean that the building itself is poorly constructed.

The air permeability and therefore the heat loss air infiltration parameters will be enhanced beyond the values required by Approved Document L2A.

For schools the best practice figure is $3m^3/h/m^2$ at 50 Pascals and this figure will ultimately be targeted for this project.

This figure is still well below the allowable value of 10 stipulated within Part L of the Building Regulations

As air leakage accounts for a significant proportion of the overall energy loss then robust detailing of the building fabric and identifying the surfaces within the building that will form the air barrier are key to keeping the building Lean, a more complex building with awkward envelope may introduce more detailing problems, so designing for air tightness is fundamental in keeping energy usage down

Built Form and Fabric Properties

The building construction material and the increased levels of insulation will go beyond the minimum requirements required by Part L of the Building Regulations (2013) and the following shall be targeted for the external walls, roof and glazing.

External Wall	0.23 W/m^2K
Ground Floor	0.20 W/m^2K
Roof	0.18 W/m^2K
External Windows	1.6 W/m^2K (Average)

Glazing & Thermal Comfort

The project glazing has been optimized to give a balance of good day lighting availability yet preventing the risk of solar overheating during the summer months.

The Baseline Target model (Part L) assumes that the lesser of either 1.5m high x full facade OR 40% of the exposed building façade is glazed, so the Be Lean design needs to be an improvement on this convention. However, reducing the glazing too much can have a detrimental effect on the daylighting availability and will require the artificial lighting to be on longer, so a level has to be reached where good day lighting does not compromise the heating and cooling loads of the building. Having a slightly higher heating load far outweighs the cost of running artificial lighting.

A further measure to reduce the risk of overheating is by utilising low emissivity glass. Typically we will provide a HIGH light transmitting glass with a LOW solar transmission value (g- value); Ideal values from our study would be around 65-70% for the light transmission and a g-value of 0.35-0.4 for the solar transmission.

From our separate TM52 and climate based daylighting compliance studies – we have chosen a glazing type that provides both good daylighting and good solar thermal performance – the chosen glazing is as follows:-

North Facing - Light transmission of 70% and a g-value of 0.70 (no requirement for solar control due to not in direct sunlight).

South, East & West Facing - Light transmission of 65% and a g-value of 0.37

In addition we are proposing glazing with an Argon cavity fill to reduce heat loss during the winter months.

‘BE CLEAN’ approach

The following section details the development of the building and the evidence of the key considerations undertaken to ensure we are designing a building that is ‘clean’ and ensuring we minimise the use of energy and what energy we do use it is used efficiently and minimising waste.

Natural Ventilation

Where ever possible a natural ventilation strategy has been adopted, as this will require very little or no energy input.

Summertime ventilation is to be provided with manually openable windows

Mechanical Ventilation

Wherever mechanical ventilation is required the mechanical ventilation system shall incorporate heat recovery to reduce energy consumption and improve the efficiency of the systems. In addition wherever possible these systems shall be controlled via both temperature and CO2 to maximise energy efficiency and shall operate on a variable volume basis to maximise energy efficiency throughout their operation

High Efficiency Lighting

In line with Building Bulletin 87 and approved document L2A high efficiency lighting will be provided to achieve a lighting efficacy no less than 65 lamp lumens per circuit Watt

As part of the development of the energy strategy we have ensured that the lighting solution is both energy efficient and provides good uniformity within the task area

From our studies we have selected the lighting solution that provides both good energy efficiency and meets the required uniformity

All lighting used on the project both internally and externally will utilise LED technology which will not only reduce energy consumption but also reduce ongoing maintenance costs

Daylighting controls

Energy consumed by lighting is a major energy demand on schools and allied to the selection of energy efficient light fittings; we are proposing intelligent lighting controls to further reduce the energy consumed by the lighting systems. The lighting controls will include the following

- Presence and absence detection is to be provided to all circulation and staff areas to ensure lighting is only energised when areas are in occupation
- Daylight linked lighting control to automatically switch lighting off when there are suitable levels of natural daylight
- Photocell and time clock lighting controls to external light fittings

Variable Speed Drives

To reduce the energy consumed by pumps and fans throughout the school wherever possible variable speed drives will be provided to ensure energy efficient operation of these systems.

Air Handling Plant

Any air handling units and extract fans will be designed to meet and wherever possible exceed the minimum Part L standards for Specific Fan Powers,

Air handling plant will incorporate heat recovery components to maximise energy efficiency

Controls/ Building Management System

The School will be provided with a building management system (BMS) this system will provide control and monitoring of the various building services systems.

Intelligent outstations will be positioned throughout the development in strategic locations adjacent to the services being controlled/ monitored. The controls will optimise the operation of the systems to ensure efficient performance.

There will be a provision for metering and alarms for out of range values.

'BE GREEN' approach

Under the planning requirement 10% of the buildings energy demand shall be provided via low and zero carbon technology or renewable energy

The school will therefore be provided with some form of renewable energy to meet this requirement. The table below appraises potential renewable energy technologies based on the site specific constraints.

Technology	Brief Description	Benefits	Limitations	Cost effectiveness	Considered Feasible	Reasons for exclusion?
Photovoltaic Panels (Solar)	Photovoltaic installations formed of an array of PV panels convert energy from sunlight into electrical energy. Efficiencies are quite low but improving as the technology advances. Typical efficiencies are between 10% for the least expensive thin film panel. 15-19% for a polycrystalline version up to 17-21% for the best quality monocrystalline panels. PVs convert electrical energy directly into DC voltage which must first be converted via inverters to AC to be useful in a building. There are 2 main types of systems, grid-connected and stand-alone. Stand-alone systems are common in remote areas. The grid-connected systems use an inverter to ensure the power generated is matched to the characteristics the grid requires for voltage, phase etc. A G83/G57 safety device is required to isolate the supply to the grid in the event of grid failure.	Wide range of installation options, flat roofs, building facades, glass roof structures and solar shading devices. Can be grid connected which could allow some beneficial payments for exporting electricity to the grid. Low maintenance once installed. Building integrated arrays can be built into the building structure/façade. Eligible for government Feed in Tariffs.	Relatively high installation cost. Periodic cleaning required, although this is still considered low maintenance.	Low however much improved with feed in tariff applied.	Yes	N/A
Solar Thermal Generation	Solar thermal systems use a solar collector usually roof mounted, the sun heats fluid within the collector which in turn is used to heat water stored in a tank which can then be used usually for washing and cleaning. There are 2 main types of collector, flat plate collectors and evacuated tube collectors. The latter is more expensive but more efficient.	Evacuated tubes offer higher obtainable water temperatures which could be used for space heating applications. Proven technology with a range of collectors available	Flat plate collectors have a relatively low efficiency; evacuated tubes are better but are more difficult to incorporate as they cannot be embedded in roof structures. The major issue is high stagnation temperatures when not in use as well as for educational projects an unfortunate offset between demand and generation. i.e. the most hot water generation is available during the summer when educational buildings are generally closed or at the least have reduced demand.	Medium	No	Solar Thermal generation does not easily align with the demand associated with a school, i.e. closed for summer when solar generation potential is highest
Wind	Wind turbines convert wind energy	Allow electrical	Performance in city	Low, but	No.	No, the site

Technology	Brief Description	Benefits	Limitations	Cost effectiveness	Considered Feasible	Reasons for exclusion?
Turbines	(kinetic energy) into electrical energy via rotating blades. There are 2 basic types, horizontal axis and vertical axis with the classic horizontal axis; windmill' type being by far the commonest. Outputs vary hugely from a few hundred Watts up to several MW of output.	generation on-site. Can be grid connected to benefit from exporting energy. Very visual, high impact if advertising 'green' credentials is a factor	locations is not likely to be good or reliable. A host of planning issues come into effect with turbines being very controversial for local communities. Building mounted turbines can create vibration and noise issues. Actual real world output can vary and can be significantly lower than the theoretical output.	varies greatly with location.		location and planning sensitivities would make a wind turbine which is large enough very difficult to achieve. Also the payback estimates for a wind turbine in a city centre location are prohibitive.
Biomass Heating	Biomass usually in the form of wood or wood pellets may be used in biomass boilers to generate heat for heating and hot water. Biomass has become popular in recent years owing to its ability to produce continuous output unlike other renewable sources such as wind. Biomass benefits the environment because the organic material that goes into making biomass uses significantly less energy to produce than it releases when it is burnt. Biofuels are also available derived either from waste products such as cooking oil, or from energy crops such as biodiesel from rapeseed.	A biomass fuels can be used to generate continuous energy supplies which makes biomass a good substitute for fossil fuels. Biomass can be a source for both heat and electricity if used with a CHP system. Proven technology with lots of choice in the market place for boilers with capacities to meet applications from very small to very large.	Biomass systems have quite onerous requirements in terms of their sourcing, delivery and storage. The lower energy density of biomass compared to fossil fuels means that bulk storage can become quite large and must be specially designed to facility delivery and feed to the boilers. Biomass (wood chip, pellet or waste wood) boilers are not efficient at part load and have longer start up and cool down times than a conventional gas fired boiler. A buffer vessel or, suitably sized natural gas boiler may be required to absorb fluctuations in load.	Medium, more expensive than traditional gas boilers.	Yes	No. storage of bio mass fuel and deliveries to an urban/ residential location are problematic. There is also a sacrifice in BREEAM score for NOx emissions. Maintenance is also more intensive than traditional gas boilers and is unlikely to be acceptable by the school's maintenance team
Ground Source Heat Pumps	Ground source systems use aquifers deep below ground to make use of the relatively stable ground temperatures. Through the use of a heat pump system to exploit the temperature difference between the ground and the building to provide either cooled water for cooling or heated water for heating. There are 2 distinct types; open loop and closed loop. Open loop systems comprise of 2 boreholes, a cold well and a warm well. Water is extracted from one and put back into the other with heat exchanged to/from the water during the process. The chilled water can be used by chilled beams or similar to provide cooling, some heat pump units can also produce hot water for heating from ground water temperatures.	Reduces or negates the requirements for mechanical cooling. Can be combined with heat pump technology to provide benefit for heating and cooling.	Boreholes are costly, their output is also largely dependent on ground conditions which may be estimated before drilling but only confirmed by a test borehole drilled before commencement of the main scheme. Open looped systems are not appropriate for ecologically sensitive areas, they are also prone to blockages and biological fouling.	Medium, depends on borehole array	No	The capital expenditure of sinking deep boreholes below the building is prohibitive, the level of EFA funding would not permit such a scheme without additional finds which are not available even though the relative payback may

Technology	Brief Description	Benefits	Limitations	Cost effectiveness	Considered Feasible	Reasons for exclusion?
	Closed loop systems rely on closed boreholes drilled into the ground which contain pipework loops through which water (or brine solution) is passed in order to exchange heat with the ground. Because the ground is a constant temperature heat can be extracted during the winter for heating and 'coolth' exchanged from the ground for summer cooling.		Over time, particularly with closed loop systems, the ground array can become overloaded and the ground temperature could increase or decrease which could reduce the effectiveness of the installation.			be attractive, CAPEX is a stumbling block. There would also be a risk to the client and to BAM that borehole performance may be poor which could have programme as well as cost implications.
CHP/Micro CHP	Combined Heat and Power or co-generation comprises of an engine which produces mechanical power from a fuel such as gas, diesel or bio-diesel predominantly in building use the engine is a gas engine type which will run on natural gas. The engine or prime-mover is coupled to an integral generator which generates power. The waste heat from producing the electricity is then used for space heating and domestic hot water generation. CHP units are available from Micro units of 5kWe up to very large scale units of 50MWe. Commonly in buildings we would be interested in Micro (<5kWe) or Mini (5-500kWe). CHP units may also be coupled to absorption chillers which can make use of excess waste heat to produce chilled water for cooling purposes. The coefficients of performance are poor compared to conventional chillers in the region of 0.7-1.2 but with waste heat as the fuel, the machine is recovering energy which may otherwise be wasted.	Can be used to produce electricity and heat on site May be used continuously unlike some other renewable technologies. CHP can utilise natural gas or use renewable fuel sources such as biogas or biodiesel. Can be coupled with absorption chillers to provide tri-generation. Good efficiencies are available if sized correctly and designed to recover as much waste heat as possible.	CHPs should be sized for the stable base load meaning addition plant is often required to make up the remaining load. CHP systems must be sized correctly to avoid excessive amounts of waste heat and/or the unit being unable to operate at times of lower demand. Regular planned maintenance required.	Medium, depends on the utilisation of waste heat	No	A CHP which is large enough to contribute 10% of the energy consumed on site by renewable means would produce an excessive amount of waste heat which could not be used effectively. High capital cost is also an issue.

Following the renewable technology appraisal, photovoltaic panels have been deemed to be the most appropriate renewable technology. As such a further analysis has been undertaken to confirm the required system size.

Calculating the Renewables Requirement

Rugby Free School

A baseline Part L analysis has been undertaken to determine the building's estimated energy consumption and associated CO_2 emissions. The following table outlines the anticipated energy consumption by end use.

Energy Consumption (End Use)	Actual	Notional
Heating (gas)	28.53	26.04
Cooling (elec)	0	0
Auxillary (elec)	2.71	2.5
Lighting (elec)	10.51	14.74
Hot water (gas)	26.21	26.29
Equipment (elec)[1]	20.53	20.53
Total (excluding Equipment)	67.96	69.57

As can be seen from the table above there are significant reductions in energy consumption by using energy efficient LED lighting, and the heating loads are comparable to the notional building even though the hybrid ventilation system proposed does not benefit from heat recovery (as the equivalent Notional ventilation system would do).

Next, it is important to include for unregulated energy consumption as required in section 5.4 of the SPD. In order to use a suitable figure the EFSA's energy modelling guide has been used, which gives required targets for all energy uses in education buildings. In the case of a secondary school the benchmark for equipment and small power is 25kWh/m^2 per year.

Therefore the total anticipated energy consumption figures are as follows;

Energy Consumption	Actual	Notional
Total including unregulated consumption	92.96	94.57

In order to determine the size of photovoltaic system required to meet the 10% obligation, it is necessary to normalise the kWh energy consumption in terms of kilowatt hours of electrical consumption. To do this we have used the methodology within the EFSA's energy modelling guide, Table 1, which outlines conversion factors for KWh for various fuels and means of generating energy.

3.2 PSBP Energy Targets

Energy Targets in PSBP are expressed as Kilowatt hour's electricity equivalent, kWhe.

kWhe is the equivalent electrical kWh calculated by multiplying the different fuel kWh consumptions for different energy sources by the following standard energy weighting factors (The Weighting Factors were developed for the Better Buildings Partnerships for its Landlords Energy Rating Scheme).

Table 1: Energy Weighting Factors

Category	Description	Energy Weighting Factor
Electricity	includes mains electricity, electricity from combined heat and power and renewable energy	1.0
All Fuels	includes, gas, oil, and biofuels	0.4
All thermal Energy	includes geothermal, district heat and heat from combined heat and power and solar thermal	0.5

1 - Table 1 from the EFA Energy Modelling Guide 2014

[1] This figure is not reflective of actual energy use so is not considered appropriate for this analysis (refer to SPD section 5.4)

The revised total figures in kWhe (electrical energy consumption), based on Table 1 are as follows;

Energy Consumption (End Use)	Actual	Notional
Heating (gas)	11.41	10.42
Cooling (elec)	0	0
Auxillary (elec)	2.71	2.5
Lighting (elec)	10.51	14.74
Hot water (gas)	10.48	10.52
Unregulated electrical consumption (elec)	25	25
Total	60.12	63.18

As such a reduction in energy consumption of 10% of 63.18kWhe would be required, i.e. **6.32kWhe/m²**.

The energy efficient measures provide a (63.18-60.12) 3.06kWhe/m² reduction; therefore the PV system will need to provide a further (6.32-3.06) **3.26kWhe/m²**, or **39134kWh/annum**.

A further Part L analysis has been undertaken, with a **56kWp** array of panels. This provides the required additional energy reduction to meet the 10% requirement.

The 56kWp array of PV panels will be approximately **280m²** of PV panel, depending on panel efficiency and size.

Quest Academy Rugby

A baseline Part L analysis has been undertaken to determine the building's estimated energy consumption and associated CO_2 emissions. The following table outlines the anticipated energy consumption by end use.

Energy Consumption (End Use)	Actual	Notional
Heating (gas)	32.35	29.2
Cooling (elec)	0	0
Auxillary (elec)	3.18	2.75
Lighting (elec)	10.51	14.09
Hot water (gas)	35.9	35.62
Equipment (elec)[2]	22.05	22.05
Total (excluding Equipment)	81.97	81.66

As can be seen from the table above there are significant reductions in energy consumption by using energy efficient LED lighting, and the heating loads are comparable to the notional building even though the hybrid ventilation system proposed does not benefit from heat recovery (as the equivalent Notional ventilation system would do).

Next, it is important to include for unregulated energy consumption as required in section 5.4 of the SPD. In order to use a suitable figure the EFSA's energy modelling guide has been used, which gives required targets for all energy uses in education buildings. In the case of a secondary school the benchmark for equipment and small power is 15kWh/m² per year.

Therefore the total anticipated energy consumption figures are as follows;

Energy Consumption	Actual	Notional
Total including unregulated consumption	96.97	96.66

In order to determine the size of photovoltaic system required to meet the 10% obligation, it is necessary to normalise the kWh energy consumption in terms of kilowatt hours of electrical consumption. To do this we have used the methodology within the EFSA's energy modelling guide, Table 1, which outlines conversion factors for KWh for various fuels and means of generating energy.

[2] This figure is not reflective of actual energy use so is not considered appropriate for this analysis (refer to SPD section 5.4)

3.2 PSBP Energy Targets

Energy Targets in PSBP are expressed as Kilowatt hour's electricity equivalent, kWhe.

kWhe is the equivalent electrical kWh calculated by multiplying the different fuel kWh consumptions for different energy sources by the following standard energy weighting factors (The Weighting Factors were developed for the Better Buildings Partnerships for its Landlords Energy Rating Scheme).

Table 1: Energy Weighting Factors

Category	Description	Energy Weighting Factor
Electricity	includes mains electricity, electricity from combined heat and power and renewable energy	1.0
All Fuels	includes, gas, oil, and biofuels	0.4
All thermal Energy	includes geothermal, district heat and heat from combined heat and power and solar thermal	0.5

2 - Table 1 from the EFA Energy Modelling Guide 2014

The revised total figures in kWhe (electrical energy consumption), based on Table 1 are as follows;

Energy Consumption (End Use)	Actual	Notional
Heating (gas)	12.94	11.68
Cooling (elec)	0	0
Auxillary (elec)	3.18	2.75
Lighting (elec)	10.51	14.09
Hot water (gas)	14.37	14.25
Unregulated electrical consumption (elec)	15	15
Total	56.00	57.77

As such a reduction in energy consumption of 10% of 57.77 kWhe would be required, i.e. **5.78kWhe/m²**.

The energy efficient measures provide a (57.77-56.00) 1.77kWhe/m² reduction; therefore the PV system will need to provide a further (5.78-1.77) **4.01kWhe/m²**, or **8340 kWh/annum**.

A further Part L analysis has been undertaken, with a **10kWp** array of panels. This provides the required additional energy reduction to meet the 10% requirement.

The 10kWp array of PV panels will be approximately **60m²** of PV panel, depending on panel efficiency and size.

The total requirement for both buildings is **47474kWh/annum** and this equates to approximately **340m²** of panels. These will be located on the roof of the Free School.

BRUKL Summary – Rugby Free School

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Rugby Free School- PV

As designed

Date: Fri Aug 11 12:23:31 2017

Administrative information

Building Details

Address: Address 1, City, Postcode

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.7

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.7

BRUKL compliance check version: v5.3.a.0

Owner Details

Name: Rugby Free School

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Ms Sepideh Gheidi

Telephone number: 01727 894200

Address: BAM Design, Building 4, Centrium, Griffiths Way, St Albans, AL1 2RD

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	20
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	20
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	16.7
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.23	0.23	01000002:Surf[21]
Floor	0.25	0.22	0.22	01000002:Surf[23]
Roof	0.25	0.15	0.15	01000002:Surf[24]
Windows***, roof windows, and rooflights	2.2	1.73	1.93	01000002:Surf[0]
Personnel doors	2.2	2.2	2.2	NR000002:Surf[2]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

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

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	3

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	12013.6	12013.6
External area [m²]	16478.2	16478.2
Weather	BIR	BIR
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	5583.83	5797.3
Average U-value [W/m²K]	0.34	0.35
Alpha value* [%]	9.97	10

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

Building Use

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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	28.53	26.04
Cooling	0	0
Auxiliary	2.71	2.5
Lighting	10.51	14.74
Hot water	26.21	26.29
Equipment*	20.53	20.53
TOTAL**	**67.97**	**69.57**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	3.49	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	94.5	80.82
Primary energy* [kWh/m²]	106.37	115.45
Total emissions [kg/m²]	16.7	20

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

BRUKL Summary – Quest Academy Rugby

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

QAR-BMD-ZZ-ZZ-MR-M-30000-S0-P02-PV As designed

Date: Wed Aug 16 10:28:59 2017

Administrative information

Building Details

Address: Rugby SEN School, Birmingham,

Certification tool

Calculation engine: Apache

Calculation engine version: 7.0.7

Interface to calculation engine: IES Virtual Environment

Interface to calculation engine version: 7.0.7

BRUKL compliance check version: v5.3.a.0

Owner Details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

Certifier details

Name: Name

Telephone number: Phone

Address: Street Address, City, Postcode

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	22.5
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	22.5
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	19.5
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a-Limit}$	U_{a-Calc}	U_{i-Calc}	Surface where the maximum value occurs*
Wall**	0.35	0.2	0.2	00000006:Surf[2]
Floor	0.25	0.22	0.22	00000006:Surf[0]
Roof	0.25	0.14	0.14	01000007:Surf[0]
Windows***, roof windows, and rooflights	2.2	1.46	1.46	00000006:Surf[1]
Personnel doors	2.2	2.2	2.2	00000028:Surf[2]
Vehicle access & similar large doors	1.5	-	-	No Vehicle access doors in building
High usage entrance doors	3.5	-	-	No High usage entrance doors in building

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
U_{a-Calc} = Calculated area-weighted average U-values [W/(m²K)]
U_{i-Calc} = Calculated maximum individual element U-values [W/(m²K)]

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

Air Permeability	Worst acceptable standard	This building
m³/(h.m²) at 50 Pa	10	5

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	2079.5	2079.5
External area [m²]	4199.6	4199.6
Weather	BIR	BIR
Infiltration [m³/hm²@ 50Pa]	5	3
Average conductance [W/K]	1309.35	1538.31
Average U-value [W/m²K]	0.31	0.37
Alpha value* [%]	11.63	10

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

Building Use

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

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	32.35	29.2
Cooling	0	0
Auxiliary	3.18	2.75
Lighting	10.51	14.09
Hot water	35.93	35.62
Equipment*	22.05	22.05
TOTAL**	**81.97**	**81.66**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	4.26	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	105.42	91.12
Primary energy* [kWh/m²]	124.52	129.84
Total emissions [kg/m²]	19.5	22.5

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.