



## **University Partnerships Programme**

**University of Reading**

**St Patrick's Hall**

**Redevelopment**

# **Energy Statement**

**November 2017**

**Rev F**

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## University of Reading

### St Patrick's Hall

### Redevelopment

## Energy Statement

**November 2017**

**Rev F**

| REV | DESCRIPTION                 | PREPARED BY | DATE          |
|-----|-----------------------------|-------------|---------------|
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| E   | Revised Planning Submission | EK          | October 2017  |
| F   | Summary of Changes          | EK          | November 2017 |

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This Energy Statement has been prepared in relation to a revised application for the redevelopment of St Patrick's Hall to provide student accommodation and associated ancillary uses. A previous application (Council Planning Ref: 161182) for the redevelopment of the site was withdrawn following the local listing of Pearson's Court within the site. This revised application retains Pearson's Court and redevelops the remainder of the site.

The changes proposed as part of this revised scheme are summarised as follows:

- There is a net reduction in student bed numbers in comparison with the previous submission. The withdrawn application proposed 1024 new student bedspaces and 6 no. three bedroom flats for families, resulting in a net increase of 726 bedspaces. The revised application provides 884 new bedspaces and would retain 116 existing bedspaces within Pearson's Court. This results in a net increase of 702 bedspaces at the site.
- The demolition of the original Pearson's Court building no longer forms part of the plans for redevelopment.
- The Sets building to the south of the Pearson's courtyard will be removed and replaced with new, high-quality accommodation; this element of the scheme has been redesigned to complement the retained courtyard.
- The proposed new courtyard to the north of the site, has increased in massing to accommodate the need for student accommodation while retaining the locally listed Pearson's Court.
- The two low-rise buildings previously proposed in the southern part of the site have been removed in response to concerns raised regarding the proximity of the buildings to the nearby house.
- New low rise accommodation is proposed set further back from the southern boundary and deeper into the site to mitigate proximity to the neighbours.
- New accommodation is now proposed above the catering Hub building and to the centre of the site.
- The Social facilities including the bar, café and dining facilities will be located in the centre of the site away from the southern boundary.
- The Combined Heat and Power (CHP) energy centre has been relocated to the centre of the site away from the southern boundary.
- Warden accommodation will be provided within the existing accommodation on the southern boundary and an updated Student Management Plan have been introduced as part of the revised application.

## EXECUTIVE SUMMARY

Reading Borough Council's planning conditions require demonstration of how the proposed energy related aspects of the redevelopment satisfy the requirements of policy CS1: Sustainable Construction and Design.

Recent changes to the Building Regulations have resulted in the revision of RBC's Revised Sustainable Design and Construction Supplementary Planning Document (SPD), which supersedes the requirement in policy CS1 to 'off-set at least 20% of the predicted carbon dioxide emissions' (all other parts of policy CS1 are still relevant).

Therefore, this (Baseline) Energy Statement has been submitted to demonstrate compliance with the Revised Sustainable Design and Construction SPD, which requires the redevelopment to;

- Achieve the required BREEAM level
- Consume less (estimated) annual average energy than the accepted energy targets
- Contain systems/plant which will reduce carbon emissions
- Include renewable technologies/low carbon energy sources

Section 2.0 of this document indicates the BREEAM Assessor's (Mecserve) Pre-Assessment report which shows that the current proposals for the accommodation blocks achieve the relevant BREEAM planning requirements.

To assess the annual energy consumptions (and corresponding carbon emissions) against accepted energy targets preliminary BRUKL calculations have been carried out for the proposed accommodation buildings.

These indicate that at an average energy consumption of the site in the region of 223.3 kWh/m<sup>2</sup> per annum (inc. plug-in loads) can be expected.

This is well within the 'Good Practice' CIBSE Guide F benchmark of 325 kWh/m<sup>2</sup>; thus satisfying the SPD requirement.

The BRUKL outputs and 'Good Practice' energy consumption benchmarks can be found in section 3.0, supported by the thermal model input data, contained in Appendix A.

An understanding of the proposals that have been considered, and those to be incorporated into the project is also required to satisfy the SPD.

Section 4.0 outlines the renewable technologies/low carbon energy sources considered, and those to be incorporated. This highlights that in addition to the passive measures and energy saving technologies proposed to be incorporated, the inclusion of combined heat and power will not only further reduce the carbon emissions (well below the level required by Building Regulations), but also will meet the recommendations under policy DM2: Decentralised Energy.

It is therefore considered that this (Baseline) Energy Statement, detailing the energy related aspects proposed for this redevelopment, satisfies the requirements of the SPD.

## 1.0 INTRODUCTION

This Energy Statement outlines the major elements considered and incorporated to deliver a sustainable and energy efficient student accommodation redevelopment, at St Patrick's Hall, on the Northcourt Group at the University of Reading.

This statement has been compiled to confirm compliance with Reading Borough Council's (RBC) 'Energy Efficiency' planning condition, namely accordance with policy CS1: Sustainable Construction and Design.

However, due to recent changes to the Building Regulations, RBC revised their Sustainable Design and Construction Supplementary Planning Document (SPD).

This SPD supersedes the requirement in policy CS1 to 'off-set at least 20% of the predicted carbon dioxide emissions' (all other parts of policy CS1 are still relevant).

This Energy Statement therefore has been submitted to demonstrate compliance with the SPD, which requires;

- the redevelopment to achieve either (as a minimum) 50% BREEAM 'Excellent' or an overall BREEAM score of 62.5% (Refer to Mecserve Pre-assessment report)
- estimated annual average energy consumption of site is not in excess of accepted energy targets (section 3.0)
- details of how carbon emissions are proposed to be reduced (section 4.0)
- details of which renewable technologies/low carbon energy sources have been considered/incorporated (section 4.0)

The above requirements are demonstrated in this statement by assessing the most appropriate energy reducing/renewable energy technology options within three principal categories (all detailed in section 4.0);

- Passive Options
- Good Practice Energy Saving Technology
- Renewable/ Low Zero Carbon Energy

The first category (Passive Options) recommends the investigation of the site layout, building orientation and design, thermal insulation levels, window designs and construction practices, all of which are incorporated within the site proposals.

Thus minimising the redevelopment's energy consumption/carbon footprint by reducing solar overheating (avoiding mechanical comfort cooling where possible) and decreasing heat losses (fabric and infiltration), while maximising natural daylight and ventilation opportunities (reducing the reliance upon artificial lighting and mechanical ventilation).

The second category extols the benefits of employing energy saving technologies considered appropriate to be incorporated within the site proposals.

The third category reviews and analyses the principal sustainable and low zero carbon technologies considered appropriate for the redevelopment.

## **2.0 BREEAM PRE-ASSESSMENT ESTIMATOR**

As previously detailed, to satisfy the requirements of the SPD, the site is to achieve, as a minimum, either a 50% BREEAM level of 'Excellent' or an overall BREEAM score of 62.5%.

The BREEAM Assessor's (Mecserve) Pre-Assessment report indicates that the current proposals achieve the relevant BREEAM planning requirements.

Further details can be found in the BREEAM Pre-Assessment document.

### 3.0 ESTIMATED OUTPUT RESULTS

#### 3.1 Predicted energy demands and carbon emissions

Preliminary BRUKL calculations have been carried out for the proposed accommodation blocks. These provide a prediction of the annual average energy consumption of the site that can be expected from each principal element, on a kWh per gross internal floor area basis.

The thermal model input data can be found in Appendix A.

|                               | Annual average estimated energy consumption (kWh/m <sup>2</sup> ) | Total annual average estimated energy consumption (kWh/m <sup>2</sup> ) |              | Total annual average estimated carbon emissions (kgCO <sub>2</sub> /m <sup>2</sup> ) |              |
|-------------------------------|-------------------------------------------------------------------|-------------------------------------------------------------------------|--------------|--------------------------------------------------------------------------------------|--------------|
| Heating                       | 55                                                                | Total fossil fuels = 184                                                | Total= 223.3 | Total fossil fuels = 40                                                              | Total = 60.4 |
| Hot water                     | 129                                                               |                                                                         |              | Total electricity = 20.4                                                             |              |
| Cooling                       | 0.3                                                               |                                                                         |              |                                                                                      |              |
| Auxiliary (fans, pumps, etc.) | 5                                                                 |                                                                         |              |                                                                                      |              |
| Lighting                      | 12                                                                |                                                                         |              |                                                                                      |              |
| Equipment                     | 22                                                                |                                                                         |              |                                                                                      |              |

The above averaged figures are based on a total site area of 21,933 m<sup>2</sup> (13 accommodation blocks).

Based on the preliminary BRUKL calculations, the total estimated annual energy consumption inc. plug in loads for the site is 4,900,000 kWh, with total estimated annual carbon emissions to be in the region of 1,325,000 kgCO<sub>2</sub>.

#### 3.2 Good practice figures/predicted energy demand comparison

A review of current industry standards (CIBSE Guide F: Energy Efficiency in building, 2012) for student accommodation has been undertaken, resulting in the following (figures are per annum);

|                                                | Energy consumption benchmark fossil fuels (kWh/m <sup>2</sup> ) | Energy consumption benchmark electricity (kWh/m <sup>2</sup> ) | CO <sub>2</sub> rating fossil fuels (kgCO <sub>2</sub> /m <sup>2</sup> ) | CO <sub>2</sub> rating electricity (kgCO <sub>2</sub> /m <sup>2</sup> ) |
|------------------------------------------------|-----------------------------------------------------------------|----------------------------------------------------------------|--------------------------------------------------------------------------|-------------------------------------------------------------------------|
| CIBSE Guide F Good Practice halls of residence | 240                                                             | 85                                                             | 51.84                                                                    | 44.12                                                                   |
| <b>Total</b>                                   | <b>325</b>                                                      |                                                                | <b>95.96</b>                                                             |                                                                         |

The total average estimated energy consumption of **223.3 kWh/m<sup>2</sup>.annum** and **60.4 kgCO<sub>2</sub>/m<sup>2</sup> per annum** of carbon emissions fall below the CIBSE Guide F 'Good Practice' benchmark figures.

#### 4.0 ENERGY REDUCING/RENEWABLE ENERGY TECHNOLOGY OPTIONS

This section reviews and analyses the principal sustainable and low zero carbon technologies appropriate for the redevelopment, culminating, in Section 4.4, with the options recommended for implementation.

##### Key:

☆ = low      ☆☆☆☆☆ = high

#### 4.1 Passive Options

| Item                                         | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Suitability | Capital Cost |
|----------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|
| Site Layout and Building Orientation/ Design | <p>Minimise overheating from solar radiation:</p> <p>A study of the annual sun paths will provide an understanding of the most effective site layout and building orientation/design, which can be carried out and incorporated during the early design stage.</p> <p><b>A review of the scheme indicates that the need for mechanical comfort cooling on the majority of the redevelopment can be avoided.</b></p>                                                                                                                                                                                                                     | ☆☆☆☆☆       | ☆☆           |
|                                              | <p>Natural Ventilation:</p> <p>Building orientation, location, use and layout can have a major effect upon whether natural ventilation can be incorporated. If these factors are correctly addressed, natural ventilation can provide a free source of fresh air and control over the internal temperature. More complicated systems contain motorised louvres and windows to control the environment, but in its simplest form openable windows are reliable and effective.</p> <p><b>Due to the site location/lack of acoustic issues it is considered that natural ventilation will be employed to most areas of the scheme.</b></p> | ☆☆☆☆☆       | ☆            |

|                        |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |       |    |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|----|
| Increased Insulation   | <p>Increase the thermal insulation to the building, thus reducing heat losses and boiler plant size.</p> <p><b>The targeted U-values for the proposed redevelopment are in excess of the Notional Building values.</b></p>                                                                                                                                                                                                                                                                                                                                                                                                   | ☆☆☆☆☆ | ☆☆ |
| Window design          | <p>In addition to consideration of the site layout, and building orientation/design, increased levels of glazing (window design) allows more daylight to enter a building, potentially reducing the dependency upon artificial light and provide better well-being of the occupants. Improved performance will also reduce solar heat gain.</p> <p><b>Although excessive increases of heat losses need to be avoided, i.e. optimum window sizes, when coupled with efficient lighting controls which can operate lighting in relation to the amount of natural light, high levels of energy savings can be achieved.</b></p> | ☆☆☆☆☆ | ☆☆ |
| Construction Processes | <p>The Building Regulations require a maximum of 10 m<sup>3</sup>/h/m<sup>2</sup> at 50 pascals for the air leakage rates from a new building, the lower this figure the less energy is lost from the inside of a building to outside.</p> <p><b>With good construction processes and approved details incorporated it is targeted that a rate of 3 m<sup>3</sup>/h/m<sup>2</sup> will be achieved.</b></p>                                                                                                                                                                                                                  | ☆☆☆☆☆ | ☆  |

## 4.2 Good Practice Energy Saving Technology

To satisfy the requirements of the current Building Regulations and also BREEAM targets, the following good practice energy saving technologies are generally considered to be within the 'baseline' requirements.

However, each has been considered on their particular merits to assess individual suitability for this redevelopment.

| Item                                                                 | Description                                                                                                                                                                                                                                                                                                                                                                            | Suitability | Capital Cost |
|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|
| Low NOx, high efficiency condensing gas fired boilers/ water heaters | <p>High efficiency condensing plant provide many benefits, including up to 10% savings in (gas) energy demand when compared to modern low temperature non-condensing plant.</p> <p><b>The systems proposed for this redevelopment will provide the opportunity to assess a variety of primary temperatures and controls, permitting substantial energy savings to be realised.</b></p> | ☆☆☆☆☆       | ☆☆           |
| Inverter Controlled Pump Motors                                      | <p>The close matching of pump power to the required pump performances will provide significant reductions in (electric) energy demand.</p> <p><b>The main booster pump set, primary pumps and the secondary heating circulation pumps within each building present a good opportunity to achieve these reductions.</b></p>                                                             | ☆☆☆☆☆       | ☆☆           |
| Comprehensive Sub-Metering Facilities                                | <p>The installation of sub-meters correctly located within building services systems can provide essential information regarding energy usage, permitting close monitoring (and hence reducing energy wastage) to be achieved.</p> <p><b>It is intended to provide a fully operational BMS including all necessary controls and cabling.</b></p>                                       | ☆☆☆☆☆       | ☆☆           |

|                                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |       |     |
|---------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-----|
| Water Flowrate Regulation             | <p>The reduction of water usage/wastage is obviously important, and combined with a saving in the energy used to heat the water makes this option more attractive.</p> <p><b>The regulation of water flowrates to appliances are proposed to be incorporated within the water services.</b></p>                                                                                                                                                                                                                                | ☆☆☆☆☆ | ☆   |
| Internal and External Lighting Design | <p>High efficiency luminaires utilising long life lamps with dimmable low loss ballasts (internal) / LED technology provide an effective energy saving over conventional luminaires.</p> <p>When installed with effective controls providing presence and daylight linked switching energy saving in excess 15% can be made.</p> <p><b>High efficiency luminaires are to be incorporated throughout the buildings, with presence and daylight (where appropriate) linked control within general and circulation areas.</b></p> | ☆☆☆☆☆ | ☆☆☆ |

### 4.3 Renewable Energy (Low Zero Carbon) Technology

| Item                            | Description                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Suitability | Capital Cost |
|---------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------|--------------|
| Wind Turbines                   | <p>Electrical generation from wind turbine units, either individually or grouped together to form a 'wind farm'. Ideally the turbines would be sized to cope with the electrical base load, or if larger can potentially export electricity back onto the grid.</p> <p><b>Although the site is largely open, the use of wind turbines would not only impinge on the visual appearance of the site and the local habitat, but also potentially create noise issues for the residences.</b></p>                                                                                                                                                                                                                | ☆☆          | ☆☆☆          |
| Ground Source Heat Pumps (GSHP) | <p>These systems would be buried in the surrounding area to provide a constant temperature water supply, which would need to be coupled to the heating system of each building served.</p> <p><b>A large area of surrounding land would be required to make this option viable, or a 'pile' arrangement could be considered depending upon ground conditions.</b></p> <p><b>An initial review of the site and its conditions indicates that a GSHP solution could be employed, but would impinge on and sterilise the surrounding area.</b></p>                                                                                                                                                              | ☆☆          | ☆☆☆☆         |
| Air Source Heat Pumps (ASHP)    | <p>These systems use a refrigerant based heat pump system similar to that used for air conditioning systems, providing energy which can be put through a heat exchanger to provide either hot or cold water for use in underfloor heating systems or hot water generation. The units use electricity to power but with a typical coefficient of performance of 4, therefore providing an efficient use of energy.</p> <p><b>This option would need a large external compound for the external units, possibly introducing noise issues. These types of systems are coming under scrutiny for their validity as a LZC technology as their energy source is electricity which has a high carbon value.</b></p> | ☆           | ☆☆☆☆         |

|                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |       |       |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------|-------|
| Solar Thermal Panels | <p>Solar thermal panels could be installed upon the buildings, and used to serve the domestic hot water systems.</p> <p>A backup hot water generation source would need to be provided to ensure desired temperatures are always reached, along with a considerable amount of roof space which would need easy maintenance access.</p> <p><b>Hot Water demand will constitute a significant part of the load of this redevelopment and as such this form of renewable technology is appropriate.</b></p> <p><b>However, as it is currently proposed that the CHP unit will also reduce the redevelopment's hot water load, these two technologies are not considered a suitable combination.</b></p>                                                                                                                                                                                                                                                                                              | ☆☆☆☆☆ | ☆☆☆   |
| Photovoltaic Panels  | <p>Either external panels mounted on the roof or integrated into the external facades, which convert the energy of the sun directly into electricity. The panels can be connected into the building's power supply to provide 'free' electricity.</p> <p><b>Roof areas are limited, and façade mounting could cause integration and planning issues, although, if incorporated the outputs could be used to offset the base electrical load (staircase lighting, external lighting, pod extract fans, etc.).</b></p> <p><b>However, as a CHP unit is currently proposed, which will provide an electrical output; this could cause conflict, regarding the achievement of maximum system efficiencies.</b></p> <p><b>Although not currently chosen for incorporation into this project, with correct control strategies, the conflict could be avoided, therefore, should additional BREEAM credits be required, the PV option (with appropriate control strategies) could be considered.</b></p> | ☆☆☆☆☆ | ☆☆☆☆☆ |
| Biomass Boiler       | <p>Biomass boilers burn wood pellets/chippings to produce heat energy which in turn serves the heating and hot water services within the building. Generally sized to cope with the base heating and hot water load, with a backup energy source (usually a gas boiler) to take up increased demand during peak periods.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | ☆☆    | ☆☆☆☆☆ |

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |      |      |
|------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------|------|
|                              | <p>These units help dramatically reduce the CO<sub>2</sub> output of a building, assist Building Regulations and BREEAM assessments. However, a steady fuel source is vital, ideally within a 50 mile radius, so CO<sub>2</sub> reductions are not cancelled out by fuel delivery pollution.</p> <p><b>Biomass boilers require constant maintenance and attention to ensure they are working correctly and efficiency.</b><br/> <b>Additional plant space for the biomass boiler and its storage would be required, and unacceptable odours have been registered on similar sites.</b></p>                                                                                                                                                                                                                                                                                                     |      |      |
| Combined Heat & Power CHP    | <p>CHP systems generate both heat and electricity in roughly a 2:1 ratio. The units can be located within dedicated plantrooms or within dedicated external acoustic enclosures.</p> <p>To ensure the units are at maximum efficiency the heating load must be constant throughout the year, which is why CHP systems often used for heating swimming pools.</p> <p>CHP systems are becoming more popular in multi-residential buildings in lieu of Biomass due to the low CO<sub>2</sub>/NO<sub>x</sub> benefits, clean operation, ease of maintenance and security of fuel source.</p> <p><b>The use of the waste heat suits the expected energy load of this redevelopment, while avoiding excessive carbon production. Therefore, this option is considered viable for this redevelopment and is included in the proposals, which also satisfies policy DM2: Decentralised Energy.</b></p> | ☆☆☆☆ | ☆☆☆☆ |
| Centralised District Heating | It is understood that currently there are no appropriate district heating schemes in the local vicinity.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | N/A  | N/A  |

A more detailed assessment of the viability of the above technologies is included in the Low Zero Carbon Feasibility Report, produced to satisfy the BREEAM Ene 04 requirements.

#### 4.4 Selected Options

The following mechanical and electrical services options/technologies are to be incorporated within this scheme;

##### Passive Options

- Increased thermal insulation
- Low air infiltration losses
- High levels of natural daylight
- Maximise the use of natural ventilation

##### Good Practice Energy Saving Technology

- Low NOx, high efficiency condensing gas fired boilers/water heaters
- Inverter driven motors, for variable power output matched to actual usage (not on/off)
- Comprehensive sub-metering facilities
- Water flowrate regulation
- Energy saving high efficiency light fittings and lamps
- Lighting controls incorporating presence and daylight linking
- Low energy LED lamp technology to reduce energy usage
- Comprehensive Building Management Systems for control and monitoring

##### Low Zero Carbon Technology

- Combined Heat & Power (CHP)

## APPENDIX A: THERMAL MODEL INPUT DATA

In order to simulate/quantify the energy use at this stage, the accommodation buildings have been 'modelled' using Integrated Environmental Solution (IES) thermal modelling and energy simulation software.

This software provides compliance simulation to meet Building Regulations (Part L2) with notional pre-set building use profiles.

The IES / BRUKL output does not reflect 'real' building operation or use.

The principal design criteria used to produce the IES simulation model is:-

|                                                                         |                                                                                                                                                                                                                                                                     |
|-------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Regs:</b>                                                            | Part L2 (2013) England & Wales                                                                                                                                                                                                                                      |
| <b>BRUKL compliance check version:</b>                                  | v5.2.g.3 (detailed design will include for v5.3.a.0)                                                                                                                                                                                                                |
| <b>Calculation engine version:</b>                                      | 7.0.5 (detailed design will include for 7.0.7)                                                                                                                                                                                                                      |
| <b>Building type:</b>                                                   | Student Accommodation - University                                                                                                                                                                                                                                  |
| <b>Compliance weather file:</b>                                         | London_TRY                                                                                                                                                                                                                                                          |
| <b>Architectural drawings:</b>                                          | Models created based on Architectural Planning drawings received on 25/11/15 by Willmore Iles Architects, which have been updated where required based on Planning drawings received on 24/05/16. Further update included for the amended site plan dated 21/09/17. |
| <b>Air Permeability @50pa (based on UPP Sustainable Design Policy):</b> | 3 m <sup>3</sup> /(h.m <sup>2</sup> )                                                                                                                                                                                                                               |
| <b>U Values (based on UPP Sustainable Design Policy):</b>               | Windows: 1.40 W/(m <sup>2</sup> K) [inc.frame]<br>g-value: 0.40, total shading coefficient: 0.46, light transmittance: 0.71                                                                                                                                         |
|                                                                         | External walls: 0.18 W/(m <sup>2</sup> K)                                                                                                                                                                                                                           |
|                                                                         | Roof: 0.10 W/(m <sup>2</sup> K)                                                                                                                                                                                                                                     |
|                                                                         | Ground floor: 0.12 W/(m <sup>2</sup> K)<br>High Usage Entrance Doors: 3.5 W/(m <sup>2</sup> K)                                                                                                                                                                      |
| <b>Heating/Hot water boilers seasonal efficiency:</b>                   | 92%                                                                                                                                                                                                                                                                 |
| <b>SFP for mechanical ventilation system of bathroom pods:</b>          | 0.5 W/(l/s)                                                                                                                                                                                                                                                         |
| <b>Lamp efficacy for all areas:</b>                                     | 60 lm/cW                                                                                                                                                                                                                                                            |
| <b>Lighting controls:</b>                                               | Baseline model does not include for lighting controls                                                                                                                                                                                                               |
| <b>Power factor correction unit:</b>                                    | YES                                                                                                                                                                                                                                                                 |
| <b>BMS:</b>                                                             | YES                                                                                                                                                                                                                                                                 |

### Carbon emission factors:

The carbon emission rates cited within the Government's Standard Assessment Procedure (SAP) 2012 version 9.92 (October 2013) were used and they are as follows:

|              |                              |
|--------------|------------------------------|
| Electricity: | 0.519 kgCO <sub>2</sub> /kWh |
| Gas          | 0.216 kgCO <sub>2</sub> /kWh |