Energy & Sustainability Statement

Bedford House,
21A John Street,
London, WC1N 2BG

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SUSTAINABLE ENERGY CONSULTANTS

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EXECUTIVE SUMMARY

Energy Rating Services.com Ltd (ERS) has been appointed to prepare Energy & Sustainability Statement for the proposed development of Bedford House at John Street, London. This report outlines the key energy & sustainability measures to be incorporated on this new development in accordance with the Camden Council planning policies:

- **Camden's Local Development Framework. Core Strategy 2010** - November 2010
- **London Plan Chapter 5 Policies**
- **The National Planning Policy Framework (NPPF) March 2012**
- **Policy DP22 – Sustainable Design and Construction – Camden Development Policies adopted (2010)**
- **Policy CS13 – Tackling Climate Change through promoting higher environmental standards - Camden Development Policies adopted (2010)**
- **Policy CC1 – Climate Change Mitigation (Camden Local Plan 2016)**
- **Camden Planning guidance – Sustainability CPG3**

Camden's Core Strategy requires a minimum reduction of 20% from on-site renewable/LZC technology.

For non-residential development of more than 500m^2 floor space, it is required by Camden Planning guidance – Sustainability, that the proposal will need to be designed in line with BREEAM.

A BREEAM pre-assessment has been carried out for the new extension proposal in order to assess the feasibility of the application of the scheme. Results show that the current total score for the new extension of the building is 70% which corresponds to 'Excellent' rating.

The aforementioned requirements have been achieved by a combination of energy efficiency measures; a fabric first approach has been considered to improve the thermal performance of the building envelope and secondly high efficient systems such as a Heat pump system to provide Cooling and Heating and improved lighting have been implemented to get a Carbon reduction of 4%. Only the renewable measures have been considered to increase the efficiency of the building in order to achieve a total reduction in Carbon emissions of 20% compared to the baseline scenario.

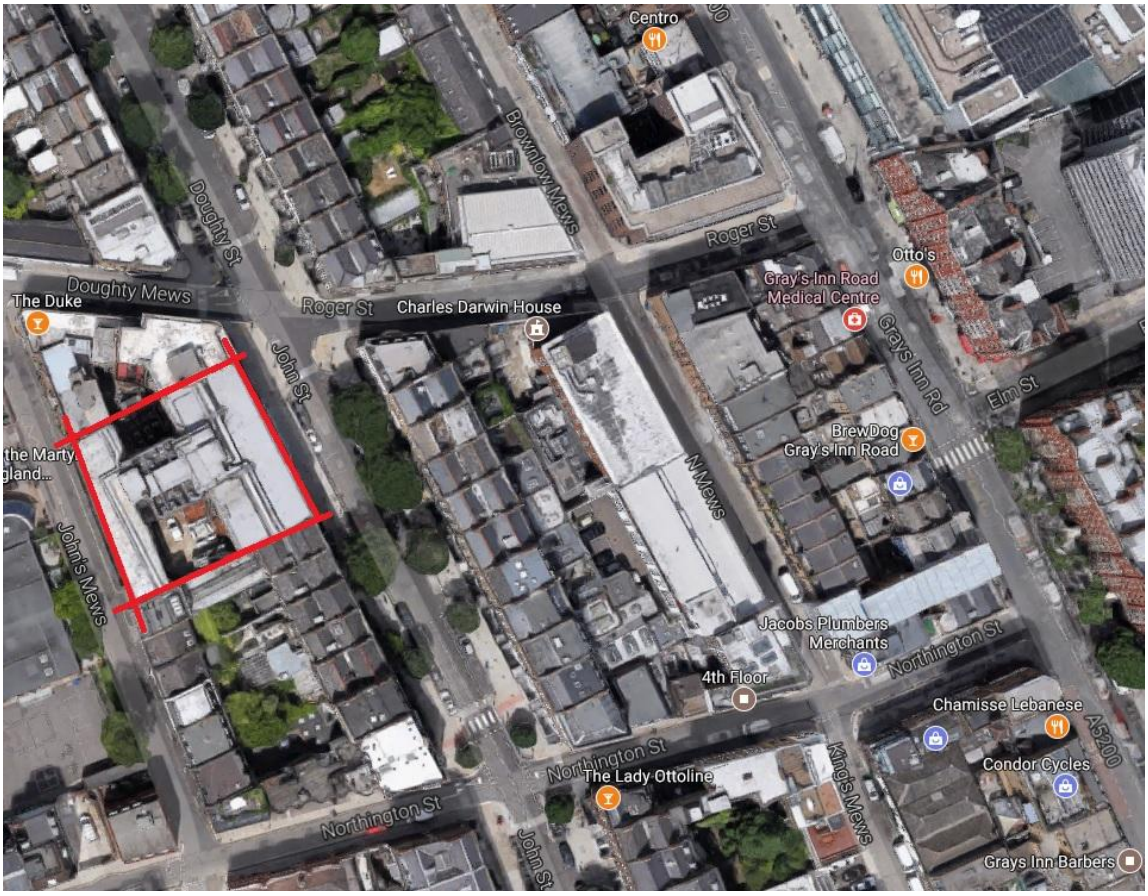

Figure 1 – Location of Bedford House at 21A John Street, London

Based on the incorporation of the ‘good practice’ energy efficiency measures included in the sustainability statement, the development’s energy consumption and resulting carbon emissions are presented (fuel assumed in this case to be natural gas). This is to compare the energy consumption and subsequent CO2 emissions before and after renewable energy & efficiency measures.

The incorporation of energy saving measures, low carbon technologies and renewable energy sources follows a hierarchy of measures based on the priority given to different carbon reduction techniques will reduce the total energy consumption. Of primary importance is the minimisation of energy requirement due to the incorporation of good practice energy saving techniques (“be lean”). Only after these measures have been incorporated a minimisation of losses associated with the supply of energy should take place (“be clean”). The final level of the hierarchy is concerned with renewable technologies be considered (“be green”)

The following energy saving technologies will be incorporated where possible to minimise the development’s energy requirement:

- Low air permeability of facade
- Improved U value
- High performance Low E double glazing
- Efficient condensing A rated boilers

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- Energy efficient lighting

The range of possible on-site renewables (also referred as low or zero carbon (LZC) energy sources) is then outlined and assessed in terms of the feasibility given site constraints and expected demand profiles. The estimated CO2 savings are calculated based on the most feasible LZC options. Finally, the energy efficiency, renewable and other sustainability options are summarised with reference to the requirements of the Planning Guidance documents.

All calculations within the report, for the analysis of the proposed building, were based upon approved Carbon Checker Software V.1.8.1.

Figure 2 – Proposed Rear Elevation at 21A John Street, London

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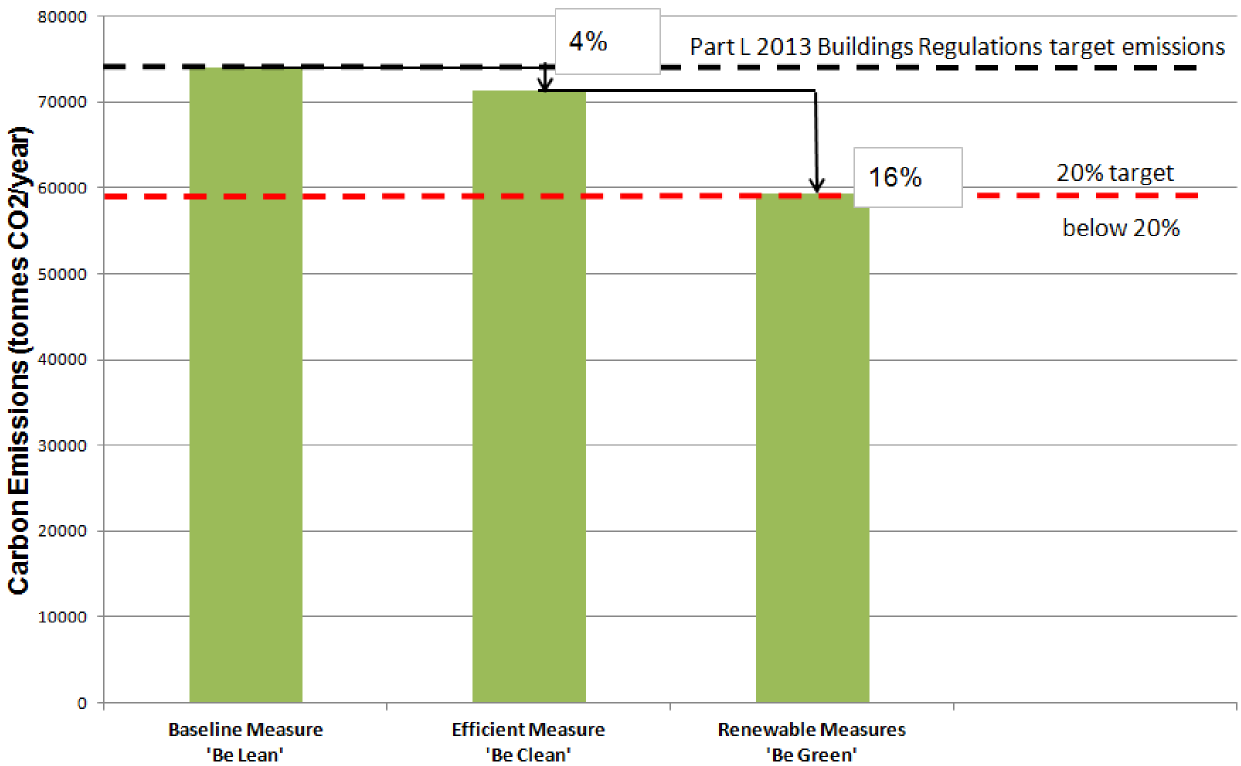
ENERGY & CARBON DEMAND SUMMARY

Table 1 Energy and Carbon Reductions

	Energy demand (kWh)	Energy demand savings (%)	CO2 Emissions (kg/yr)	CO2 Emissions savings (%)
baseline scheme	438020		74006	
Scheme After Energy Efficient measures	422417	4%	71404	4%
Proposed scheme with renewable/ LZC	376114	14%	59335	20%

Figure 3 Carbon Emissions Reductions



As shown in Table 1, the estimated annual baseline energy consumption of the proposed new office extension is in the order of 438020 KWh/yr. The resulting annual carbon dioxide emissions are approximately 74006 kg CO_2/yr.

As we can see from the above by taking energy efficiency measures and LZC technology such as PV the energy usage will be reduced by 14% and CO_2 emissions by 20%.

SECTION 1 INTRODUCTION

OBJECTIVE

This document has been prepared with reference to the:

- **London Borough of Camden planning policy requirements**,
- **CPG 3 Camden Planning Guidance – Sustainability**
- **Policy DP22 – Sustainable Design and Construction – Camden Development Policies adopted (2010)**
- **Policy CS13 – Tackling Climate Change through promoting higher environmental standards - Camden Development Policies adopted (2010)**
- **Policy CC1 – Climate Change Mitigation (Camden Local Plan 2016)**
- **London Plan Chapter 5 Policies**

The report seeks to address at a preliminary level the requirements in terms of sustainability and renewable energy.

The proposed development has been treated as self contained in terms of heating and hot water supply. However the potential for using distributed heating from a central energy centre has been considered.

SUMMARY

The proposal is for a single storey vertical extension to a commercial building located at John Street, London to house new office facilities.

The key sustainability measures to be incorporated in the design are outlined in Section 2 below. These correspond with the project's aspiration to achieve the best practicably possible for non-residential development. Based on the incorporation of the 'good practice' energy efficiency measures included in the Sustainability Statement, the development's energy consumption and resulting carbon emissions are presented. For clarity these figures have been broken down by fuel type (electricity and fossil fuel, assumed in this case to be natural gas). The range of possible on-site renewable (also referred as low or zero carbon (LZC) energy sources) is then outlined and assessed in terms of the feasibility, given site constraints and expected demand profiles. The estimated CO2 savings are calculated based on the most feasible LZC options.

CALCULATION METHODOLOGY

All energy figures have been calculated using approved software NHER, BuildDesk Carbon Checker V.1.8.1 to provide evidence of compliance with the Building Regulations as well as amount of improved carbon emissions for the development.

The carbon emissions factors used in all calculations in this document are those published in Table 2 of Part L2A of the Building Regulations. The relevant factors are reproduced in Table 2 below.

Table 2 Carbon emissions factors by fuel type

Fuel	CO_2 emission factor ($kgCO_2/kWh$)
Natural Gas	0.194
Biomass	0.025
Grid supplied electricity	0.422
Grid displaced electricity	0.568

SECTION 2 ENERGY STATEMENT

2.1 OVERALL SITE ENERGY CONSUMPTION AND CARBON EMISSIONS

The overall energy consumption of this building with the proposed extension has been calculated to be 438020 kWh/year.

Camden's Core Strategy requires 20% reduction of CO2 emissions from on-site renewable or LZC technology. For this small scale development high efficient Heat Pump for heating and cooling in conjunction with 12 kWp PV panels (48 panels 1.6 m^2 each) would reduce total CO2 emissions by 20%. The development's overall carbon emissions will depend on a mixture of fuels used. Electricity generates zero carbon at the point of use but has a relatively high carbon emission factor due to the inefficiencies of generation (principally from natural gas and coal) and distribution. Natural gas has a lower carbon factor, even when on-site boiler efficiency and distribution losses are considered. The carbon emission factors used for the calculations in this section are as follows:

- Grid Supplied Electricity 0.422 $kgCO_2$ / kWh
- Natural Gas 0.194 $kgCO_2$ / kWh

The detailed evaluation of the proposed scheme resulted in total annual energy consumption of 376114 kWh/year and 59335 kgCO2/year emissions.

2.2 RENEWABLE ENERGY SOURCES

INTRODUCTION

This section provides an overview of the technologies considered, a brief assessment of their feasibility, a proposed mixture of suitable technologies and finally an estimate of the achievable carbon reductions due to LZC energy sources.

DEMAND PROFILES

The balance of technologies chosen will depend on the development's energy demand patterns. Dynamic thermal simulation will be necessary to provide the level of detail required for a more advanced LZC energy strategy. The renewable energy required for space heating and hot water might be supplied to the whole development. However, the renewable thermal energy might need to be topped up by conventionally generated space heating/ hot water to cover peak demands.

Keeping in mind that the space heating energy demand changes according to the season while hot water energy demand will provide a significant base load throughout the year.

Electrical demand is likely to be moderate throughout the year. Lighting loads will be highest during the evening but will continue at reduced levels throughout the night and during the day.

FEASIBILITY

Use and type of on-site renewable source depends on many different factors and site constraints, such as location, climate, orientation, viability, planning issues etc. A brief description and feasibility of each option are discussed below.

Further descriptions of the LZC technologies are included in Appendix A.

BIOMASS

Reliability of fuel supply, typically wood chips or pellets, has traditionally been an issue but increasing demand is improving the supply situation. Storage of fuel is also a potential issue, the volume of storage required will depend on the frequency of delivery and the fuel's energy density (pellets contain less moisture and have a higher packing density than chips, so their energy density is higher).

Biomass boilers however would need to be connected to the hot water tank acting as a buffer to smooth peak hot water demand and also allows operating a boiler in optimal conditions. It is suggested that the LZC strategy includes sufficient biomass boiler capacity to meet the majority of the annual heat demand. In addition sufficient gas fired condensing boiler capacity can be installed to provide back up.

Suitable storage space for fuel needs to be considered with this option. Due to the issues with storage of fuel and hot water storage tank and scale of the project, this option has not been considered to be suitable and viable.

GROUND OR AIR SOURCE HEAT PUMP

Ground or air source is commonly used technique to provide buildings with heating and cooling via heat pumps. Closed vertical boreholes or active thermal piles are the main two ways feasible of extracting heat/coolth from ground. The system works most efficiently if annual heat and cooling energy supply by the system is in balance, so the ground will not become either too hot or cold resulting in loosing heating/ cooling potential over years. Bearing this in mind the ground source heating and cooling system needs to be carefully sized and designed.

Due to the complexity of the system, condition of the ground and high cost of boreholes this is not considered as a preferred option for this small development.

Air source heat pump (ASHP) is considered a valid and appropriate energy efficient measure to apply to Bedford House at John Street, London. Due to the type and size of the building and its heating/cooling demand, ASHP has been identified as the most suitable strategy to improve the overall energy performance of the building, while providing Hot water for the office building. It is suggested to use an A-class Air-to-Water ASHP connected to radiators, with minimum COP of 3.83 and EER of 3.5, to provide space and water heating (see table below).

Table 3 – Air Source Heat Pump specifications

Air Source Heat Pump	
Type	Air-to-Water
Minimum COP	3.83
Minimum EER	3.5
Emitters	Radiators
Providing Hot Water	yes
Primary Heating electricity consumption	8.72 KWh/m^2
Primary Cooling electricity consumption	7.93 KWh/m^2

SOLAR THERMAL COLLECTORS

Solar thermal collectors (flat plate or evacuated tubes) convert solar thermal energy into heat for hot water generation. These are usually located on a south oriented roof, ideally on a 45 degrees slope. Solar collectors properly sized and designed, provide approx 40% of annual hot water demand. As hot water is not the main source of energy consumption for a commercial development, this type of renewable energy would not provide the required percentage from on-site renewable.

PHOTOVOLTAIC

PV technology will form part of the LZC strategy for the building. 1 kWp of Solar PV can produce 850 kWh/ year of electricity reducing the energy requirement and CO2 emissions.

This option has been considered to be appropriate and viable to be applied on this development to satisfy the requirements of Camden's Core Strategy from on-site renewables. As a result 12 KWp of solar PV panels have been proposed for a total array area of 76.8 m2, South oriented (see table below).

Table 4-Photovoltaic panels specifications

Photovoltaic panels	
Module Efficiency	19%
Panel Orientation	South
Tilt	Horizontal 0%
Array Area	76.80 m^2
Number of PV panels	48
Power production	12 KWp
Predicted Solar Energy production	1.79 KWh/m^2
Primary Electricity offset by the PV array	8168 KWh/yr
Total CO2 emissions reduction	12069 Kg/yr

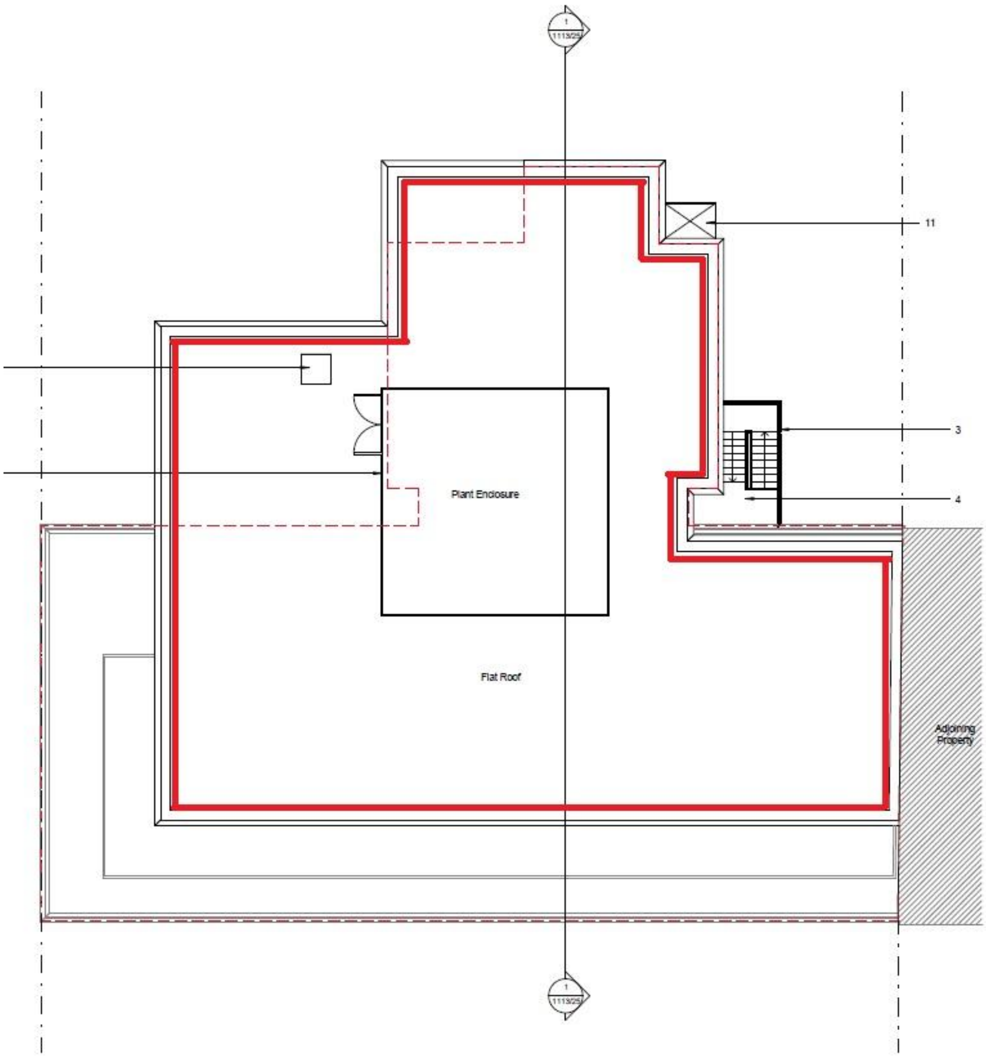


Figure 4 Proposed new flat roof with highlighted potential area for PV installation

WIND ENERGY

Energy from wind is another source of renewable energy using large or small scale wind turbines but they are highly dependent on the location, average wind speed and site constraints. Planning has been a big issue with regards to wind turbines in recent years. Also the high cost of installation and maintenance makes this option not suitable for this development.

SECTION 3 SUSTAINABLE DESIGN & CONSTRUCTION STATEMENT

3.1 INTRODUCTION

- This section expands on the sustainability issues outlined in **Camden's Local Development Framework** (Core Strategy and Development Policies 2010) and PolicyCC1 – Climate Change Mitigation (2016)

The measures required to meet the levels specified in the planning guidance are discussed.

3.2 WATER

It is possible to reduce and control the water consumption on this project. This can be achieved by applying various water efficiency and reclamation / recycling measures.

WATER EFFICIENCY MEASURES

The following measures will be used to reduce the quantity of water need to satisfy end users:

- Dual or low flush WCs
- Spray or aerating taps
- Water efficient appliances
- Low flow showers
- Smaller size bath

WATER RECLAMATION / RECYCLING MEASURES

- Rainwater collection

Water collected from the roof will be harvested for storage and used for non-potable uses such as watering gardens etc.

SUSTAINABLE DRAINAGE SYSTEMS (SUDS)

Sustainable drainage systems (SUDS) is an approach to managing surface water that aims to reduce problems of flooding and pollution associated with traditional drainage systems. The basic principles are the reduction and attenuation of run-off from the site. This is achieved by exploiting or enhancing existing natural drainage systems and/or techniques modelled on them. Any hard surfaces will be SUDS compliant.

3.3 BUILDING MATERIALS

All material shall be selected in a way to reduce the environmental impact.

The key issues to be addressed in the selection of materials and equipment are:

- Use of materials and equipment from sustainable sources
- Minimisation of in-use environmental impacts
- Minimisation of embodied environmental impacts
- Use of materials and equipment with high recycled content

3.4 Waste

A site waste management plan will be provided with details of waste minimisation, sorting, reuse and recycling procedures. Sustainable waste management should follow the hierarchy described in *BS 5906: Waste management in buildings. Code of practice*. This outlines the following principles in decreasing order of desirability:

- Considerate Constructors Scheme
- Reduce waste
- Re-use materials and equipment (and facilitate future reuse)
- Recycle waste (and facilitate recycling)
- Compost biodegradable waste
- Recover energy from waste (and facilitate energy recovery from waste)
- Disposal

3.5 Lighting & Appliances

Electricity for lights and appliances (including cooking) can account for a significant proportion of total energy costs and CO2 emissions. This will be reduced by:

- Specifying energy efficient lamps wherever appropriate and switches at all room exits. At least 75% of the light fittings will be energy efficient fittings.
- Choosing low energy A rated appliances.
- Providing occupants with information on the choice and use of low energy lights and appliances.

External lighting

Any external lighting will use either:

- Incandescent lamps with photocells (daylight sensors) and PIR with a maximum lamp capacity of 150W Or
- Energy efficient lamps (efficacy of at least 40l/W) and compatible photocell or timer.

3.6 Ecology

The site is described as a “low ecological value”. However ecology will be enhanced by several means that are possible to integrate into typical commercial development. In simple cases this can include planting a variety of vegetation around the building in plant beds or boxes to increase the attractiveness of the site to wildlife.

SECTION 4 CONCLUSION

This report assesses energy demand and carbon emissions of the proposed Bedford House building at 21A John Street, London.

Following Camden's Local Development Framework – Core Strategy (2010), the baseline energy demand has been calculated to be 438020 kWh/year and resulting CO2 emissions 74006 kgCO2/year. By using **high efficient Air source Heat pump** for space Heating/Cooling and water heating, along with **12 KWp of PV panels** (76.8 m2, horizontal tilt), energy consumption and CO2 emissions savings will be in the range of 71404 kWh/yr and 59335 kgCO2/yr accordingly. This will be 20% reduction in CO2 emissions from energy efficiency measures and on-site renewable/ LZC technology, exceeding the local planning requirements.

Due to the size and the nature of the building extension (more than 500 m^2), the **BREEAM** target will be viable for Bedford House at John Street. A BREEAM pre-assessment has been carried out to assess the feasibility of the scheme and results have shown that it can achieve a 'Excellent' BREEAM target (See Attachment).
Considering the size and the location of the building, limitations occur in regards to the design and the building. **The pre-assessment only needs to be carried out for the new extensions.**

The proposal will be designed with a high level of insulation and low air permeability to reduce heat loss as much as is practically possible, also the use of low energy lighting and A-rated White goods are essential for the reduction of energy consumption.

The control strategy throughout must be carefully designed to ensure the most economical operation of all equipment throughout the development.

From the above it can be concluded, taking into account all the conditions surrounding this site, that energy efficiency measures with above mentioned renewable technology is a feasible option to save energy, reduce CO2 emissions and to mitigate the environmental impact of this small scale development.

Furthermore, this project will satisfy the requirements of the planning department for sustainability, by introducing a combination of energy efficiency measures and on-site renewable. Summarising the proposals will provide the following:

- High level of insulation and low air permeability (aiming at maximum 15 m3/hm2 air permeability)
- Use of low energy lighting throughout the building
- A-Class Air Source Heat pump to provide Cooling/Heating and Hot water to the building; the ASHP will be connected to an underfloor heating system
- 12 KWp array of PV panels for a total roof area of 76,8 m^2 (total of 48 Solar PV panels) in optimized orientation and shading conditions to provide 8168 KWh/yr

Through all these strategies the building will achieve 20% reduction in CO2 emissions, of which 14% will account for the on-site renewables, meeting the requirements of Camden's Core Strategy (2010).

APPENDIX A - LOW OR ZERO CARBON ENERGY SOURCES

BIOMASS

Biomass is an alternative solid fuel to the conventional fossil fuels. In theory it is carbon neutral as the carbon emitted by burning is offset by the carbon absorbed during the growth of the plant. In reality, biomass fuel is not completely carbon neutral; there is a small carbon factor due to the energy used in processing and delivery.

Various types of biomass fuel are in use, the most common being the woody biomass, which includes forest residues such as tree thinnings, and energy crops such as willow short rotation coppice. Biomass is converted into a manageable form that can be directly fed to the heat or power generation plant, thus replacing fossil fuel. As a result, applications can range from large-scale heating boilers to individual house room heaters to combined heat and power generation (CHP). For building applications, the fuel usually takes the form of wood chips, logs and pellets. Wood pellets are essentially compacted high-density wood with low moisture content, thus having a higher calorific value per unit volume or weight.

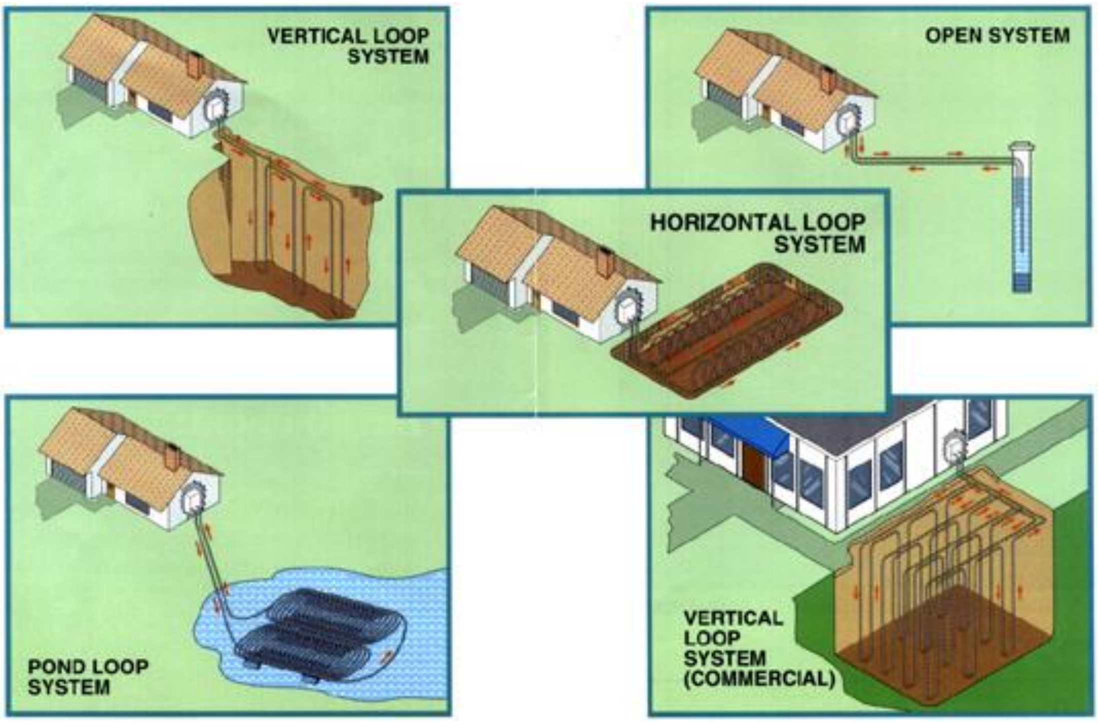
GEOTHERMAL ENERGY

Geothermal energy technologies use the heat energy stored in ground; either for direct-use applications: such as using the grounds' heat to defrost a driveway or the indirect use with additional equipment such as a geothermal heat pump. Most commercial installations couple a heat pump with the ground to upgrade the low-grade heat from the ground or ground water to a higher grade heat, where it can be used for heating purposes.

The suitability of a ground source system depends heavily on the type of earth coupling heat exchange system used:

GROUND SOURCE EARTH COUPLING OPTIONS

The right choice of appropriate heat exchanger depends on several factors such as: size of space heating/hot water system, available site area for the heat exchangers, and local ground conditions. Due to the specialist nature of this technology we recommend that a specialist is employed to size the heat exchangers based on a desk-top study of the site's geological conditions – this normally being required in advance of any other contractor appointment.



The main types of ground source heat exchanger

VERTICAL CLOSED LOOP SYSTEM

A frequently used and simple ground source heat exchanger, for a small to medium size project, is a closed loop vertical system. The system comprises of vertically drilled boreholes, usually up to 100 m deep, into which are inserted two polyethylene pipes with a U-shape connector at the base of the hole – effectively providing a flow down to the bottom of the hole and return back up to the surface. All the flow and return loops are connected together across the site - completing the entire heat exchange loop. Water is pumped around the loop and is then circulated around the heat pump to achieve the required heat exchange. The distance between boreholes is dependent on ground conditions but is typically a minimum of a 6mx6m grid, to prevent overlapping of the heat exchange process between loops.

HORIZONTAL CLOSED LOOP SYSTEM

Horizontal closed loop heat exchangers are usually applied to small projects such as individual houses, which usually require a relatively low heat output. Consisting of horizontal trenches 1.5-2m deep, with either straight pipes or 'slinky' coiled pipes, these require significant excavation work and significant site area to achieve appreciable outputs as such are not normally suited to medium to large projects.

VERTICAL OPEN BOREHOLES SYSTEM

A further option is a vertical open borehole system. The system involves the abstraction and discharge of natural ground water using boreholes; into which pumps are inserted, connected to collapsible pipework. Each borehole pump abstracts ground water, circulates it around the heat pump and then discharges the water back to the ground via an absorbing well, some distance from the original abstraction borehole. The system is capable of providing very high rates of heat exchange for a relatively small number of boreholes, which makes it very efficient in terms of site area required. However, this depends greatly on the availability of ground water, which in turn varies according to location. A major downside of this system is that the extraction of water from deep boreholes via pumps consumes a lot of energy, as the water has to be physically lifted to the surface by the pump – this in effect reduces the carbon emissions saved by this system as a whole.

Ground source heat exchange options in summary:

VERTICAL LOOP SYSTEM - CLOSED BOREHOLES

- moderate heat capacity
- relatively low installation cost

VERTICAL OPEN SYSTEM - OPEN BOREHOLES

- high heat capacity
- high running energy
- high installation cost

HORIZONTAL LOOP SYSTEM – STRAIGHT PIPES

- low capacity,
- high installation cost
- extensive ground excavation work

HORIZONTAL COILED LOOP SYSTEM – 'SLINKY' PIPES

- good capacity
- low installation cost
- extensive ground excavation work

HEAT PUMPS

Heat pumps are basically refrigeration units which work in reverse – instead of cooling being produced and heat rejected, the unit produces heat and rejects cooling. Conventional heat pumps use air as the medium to reject this 'coolth' to atmosphere. Ground source units use the ground as a means of improving the unit efficiency because the ground is a constant 11-13 °C at depths of 50m down – this suits the heat pump much better during the coldest weather than the extremes of air temperature. Reversible heat pumps can also be used for cooling, however this is not being considered further for this project.

A heat pump consumes electrical power to drive the compressor and other ancillary elements. The ratio between total energy input and heat energy output of the heat pump is a measure of its efficiency – usually referred to as 'Coefficient of Performance' - COP. A ground source heat pump has a higher COP than an air cooled heat pump – this additional energy effectively being the grounds' natural contribution to the system.

The heat produced by a heat pump is usually used to either provide space heating say to underfloor heating or radiators or the heat is used to generate domestic hot water via a storage vessel.

CHP

Combined heat and power (CHP) is a process involving simultaneous generation of heat and electricity, where the heat generated in the process in harnessed via heat recovery equipment. CHP at the large commercial size is now fairly common in premises which have a simultaneous demand for heating and electricity for long periods, such as hospitals, recreational centres and hotels. In addition, small CHP systems are now becoming available for individual houses, group residential units and small non-domestic premises. Compared with using centrally generated electricity supplied via the grid, CHP can offer a more efficient and economic method of supplying energy demand, if installed and operated appropriately, owing to the utilisation of heat which is normally rejected to the atmosphere from central generating stations, and by reducing network distribution losses due to local generation and use.

A small CHP unit – similar to the size of unit investigated

Heat generated will be used for space and water heating, and additional heat storage may be used to lengthen use periods, to assist in warm-up and to improve overall energy efficiency. For overall good energy efficiency, as with all CHP, usage must be heat demand led. Thus, a sophisticated control system is required and users should be made aware of efficient operating practices.

Solar thermal collectors

Solar thermal collectors (flat plate or evacuated tubes) convert solar thermal energy into heat for hot water generation. These are usually located on a roof oriented south facing in an ideal slope of 45 degree. Solar collectors properly sized and designed provide approx 50% of annual hot water demand.

For example approx. 35m2 flat plate solar collectors at cost of £24,000 generates around 11MWh of hot water resulting in 10% carbon savings.

However, should a CHP unit is used for hot water generation when solar collectors will be redundant.

PHOTOVOLTAIC

Photovoltaic modules convert sunlight directly into DC electricity and can be integrated into buildings. Photovoltaics (PVs) are distinct from other renewable energy technologies since they have no moving parts to be maintained and are silent. PV systems can be incorporated into buildings in various ways: on sloped roofs and fl at roofs, in façades, atria and shading devices. Modules can be mounted using frames or they can be fully incorporated into the actual building fabric; for example, PV roof tiles are now available which can be fitted in place of standard tiles.

Currently, a PV system will cost between £1500 and £2500 per kWp, and frequently part of this cost can be offset owing to the displacement of a conventional cladding material. Costs have fallen significantly since the first systems were installed (1980s) and are predicted to fall further still.

While single crystal silicon remains the most efficient flat plate technology (15–16% conversion efficiency); it also has the least potential for cost reduction. PV cells made from poly-crystalline silicon have become popular as they are less expensive to produce, although they have a slightly lower efficiency.

Thin film modules are constructed by depositing extremely thin layers of photosensitive materials on a low-cost backing such as glass, stainless steel or plastic. As much less semiconductor material is required as for crystalline silicon cells, material costs are potentially much lower. Efficiencies are much lower, around 4–5%, although this can be boosted to 8–10% by depositing two or three layers of thin film material. Thin film production also requires less handling as the films are produced as large, complete modules and not as individual cells that have to be mounted in frames and wired together. Hence, there is the potential for significant cost reductions with volume production.

Since PVs generate DC output, an inverter and other equipment is needed to deliver the power to a building or the grid in an acceptable AC form. The cost of the inverter and these ‘Balance Of System’ (BOS) components can approach 30% of the total cost of a PV system. Hence, simplification and cost reductions in these components over the coming years will also be necessary to make PV systems affordable.

WIND ENERGY

Wind power is the most successful and fastest spreading renewable energy technology in the UK with a number of individual and group installations of varying size, capacity and location. Traditionally, turbines are installed in non-urban areas with a strong trend for large offshore wind farms. In parallel with the design and development of ever-bigger machines, which are deemed to be more efficient and cost-effective, it is being increasingly recognised that smaller devices installed at the point of use, i.e. urban settings, can play an important role in reducing carbon emissions if they become mainstream.

At present there is a wide range of available off-the-shelf wind products, many manufactured in the UK and EU with proven good performance and durability. The dominant type is horizontal axis wind turbines (HAWT), which are typically ground mounted. Vertical axis wind turbines (VAWT) have limited market presence and there is a trade-off between lower efficiency and potentially higher resistance to extreme conditions. Capacity ranges from 500W to more than 1.5MW, but, for practical purposes and in built-up areas in particular, machines of more than 1kW and below 500kW are likely to be considered.

Wind technology is also currently one of the most cost-effective renewable energy technologies, which is attributable to the large scale of installations reducing the unit output cost. Individual building or community wind projects, although smaller, have the advantage of feeding electricity directly into the building's electricity circuit, thus sparing costly distribution network development and avoiding distribution losses. The downside is the still high capital cost per kW installed for smaller turbines, plus location constraints, such as visual intrusion and noise. The wind regime in urban areas is also a concern owing to higher wind turbulence which reduces the potential electricity output.

In most cases, wind turbines are connected to the electricity grid and all generated energy is used regardless of the building demand fluctuations. The output largely depends on the wind speed and the correlation between the two is a cube function. This means that in short periods of above-average wind speeds the generation increases exponentially. As a result, it is difficult to make precise calculations of the annual output of a turbine, but average figures can provide useful guidance to designers and architects. In reasonably windy areas (average wind speed of 6m/s) the expected output from 1kW installed is about 2500kWh annually.

The cost per kW installed varies considerably by manufacturer and size of machine with an indicative bracket of £2,500–£5,000. With a lifespan of more than 20 years, wind turbines can save money if design and planning are carried out in a robust way.

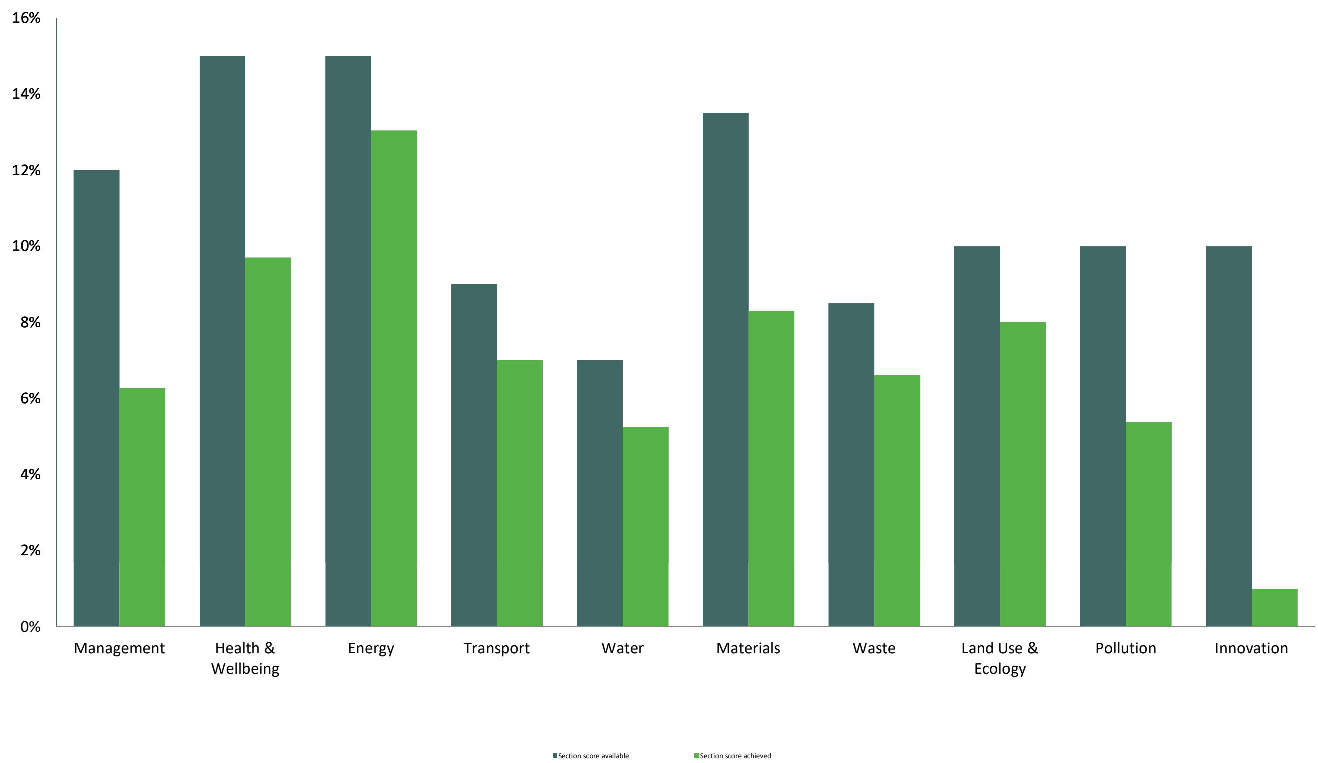
Building-integrated wind turbines are starting to be a reality in the UK, but potential projects may face difficulties with obtaining planning permission. There are a few examples now of permitted development rights for certain rooftop turbines in some local councils. A number of horizontal axis devices specifically designed for building integration are now available commercially, having design and reliability parameters relevant to the urban context. Building-mounted vertical axis devices are under development.

At present, turbines installed near buildings, as well as community installations for groups of buildings, should be regarded as the larger wind energy source related to buildings, when they contribute to the carbon emissions from these premises using ‘private wire’ networks. However, the contribution of several building-integrated turbines in a development is likely to become significant in the next few years.

Overall Building Performance

Building name	The Bedford House
BREEAM rating	Excellent
Total Score	70.5%
Min. standards level achieved	Excellent level

Building Performance by Environment Section



Environmental Section	No. credits available	No. credits Achieved	% credits achieved	Section Weighting	Section Score
Management	21	11	52.38%	12.00%	6.28%
Health & Wellbeing	17	11	64.71%	15.00%	9.70%
Energy	23	20	86.96%	15.00%	13.04%
Transport	9	7	77.78%	9.00%	7.00%
Water	8	6	75.00%	7.00%	5.25%
Materials	13	8	61.54%	13.50%	8.30%
Waste	9	7	77.78%	8.50%	6.61%
Land Use & Ecology	10	8	80.00%	10.00%	8.00%
Pollution	13	7	53.85%	10.00%	5.38%
Innovation	10	1	10.00%	N/A	1

Building Performance by Key Environmental Performance Indicator

Energy (consumption/production)	Life cycle stage	Measurement	Intensity	Units	Total	Units
Building operation[1]	Use	Modelled	40.66	$kWh/m^2/yr$	21550	kWh/yr
Energy production[2]	Use	Modelled	9.26	$kWh/m^2/yr$	INA	kWh/yr
Construction process[3]	INA	INA	INA	INA	INA	INA
Transport[4]	INA	INA	INA	INA	INA	INA
Greenhouse Gas Emissions						
Building operation[1]	Use	Modelled	10.00	$kgCO_2eq/m^2/yr$	5,300	$kgCO_2eq/yr$
Embodied[5]	Cradle-to-grave	Measured	277.17	$kgCO_2eq/m^2$	146,903	$kgCO_2eq$
	Proportion of applicable main building elements that data reported covers					100.00%
Construction process[3]	INA	INA	INA	INA	INA	INA
Transport[4]	INA	INA	INA	INA	INA	INA
Direct GHG emissions - Refrigerants[6]	Use	Modelled	INA	$KgCO_2eq/kW_{coolth}$	INA	$KgCO_2eq$
Emissions to outdoor air, soil and water						
Nitrogen Oxides (NO_x)[7]	Use	Measured	40.00	mg/kWh	INA	kg/yr
Use of freshwater resource						
Building operation[8]	INA	INA	INA	INA	INA	INA
Construction process[9]	INA	INA	INA	INA	INA	INA
Construction waste and recovery						
Construction waste[10]	Construction	Target	3.00	tonnes/100m2	16	tonnes
Construction waste diverted from landfill[10]	Construction	Target	INA	%	INA	tonnes
Demolition waste diverted from landfill[11]	-	-	-	-	-	-
Demolition waste to disposal[11]	-	-	-	-	-	-
Material for re-use[12]	Construction	Target	INA	tonnes/100m2	INA	tonnes
Material for recycling[12]	Construction	Target	INA	tonnes/100m2	INA	tonnes
Material for energy recovery[12]	Construction	Target	INA	tonnes/100m2	INA	tonnes
Hazardous waste to disposal[12]	Construction	Target	INA	tonnes/100m2	INA	tonnes
Sourcing of materials						
Materials responsibly sourced[13]	Construction	Measured	0.00%	%	-	-
Thermal comfort						
Predicted Mean Vote (PMV)	Use	Modelled	INA	Index	-	-
Predicted Percentage Dissatisfied (PPD)	Use	Modelled	INA	%	-	-
Indoor Air Quality						
Formaldehyde concentration level[14]	INA	INA	-	INA	INA	INA
Total volatile organic compound concentration[14]	INA	INA	INA	INA	INA	INA

Notes

1 Modelled using approved software compliant with the UK's National Calculation Method which in turn is compliant with Article 3 of The Energy Performance of Buildings Directive (EPBD) 2002/91/EC. Modelling includes building energy consumption resulting from the specification of a 'controlled', 'fixed building service' (as defined in the relevant Approved Document or Guidance produced for each UK territory).

2 The reported impact includes technologies that produce energy (on-site and/or near-site) as defined by Directive 2009/28/EC of the European Parliament and of the Council of 23 April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC.

3 The reported impact includes energy consumption from construction plant, equipment and site accommodation. This KPI is not assessed/reported at the design stage of assessment/certification.

4 The reported impact covers transport of the construction materials that make-up the main building elements and ground works and landscaping materials (from the factory gate to the site) and construction waste (from the construction gate to waste disposal processing / recovery centre gate). Main building elements are defined in the BREEAM 2014 New Construction Technical Guide (SD5076). This KPI is not assessed/reported at the design stage of assessment/certification.

5 The reported impact covers the construction materials that make-up the main building elements (over a 60 year study period). Main building elements are defined in the BREEAM UK New Construction2014 Technical Guide (SD5076). The data is quantified using BRE's Environmental Profiles Methodology. The Environmental Profiles Methodology has been peer reviewed to comply with BS ISO 14040 and represents the Product Category Rules for BRE Global's environmental labelling scheme (EPD - ISO 14025, Type III) for construction products and elements.

6 The reported impact is for a 10 year study period. The calculation of the Direct Effect Life Cycle CO_2eq emissions used by BREEAM is based on the Total Equivalent Warming Impact (TEWI) calculation method for new stationary refrigeration and air conditioning systems, as described in Annex B of BS EN 378-1:2008.

7 The reported impact covers emissions from either one or a combination of space heating, cooling and hot water heating (refer to Pol02 Assessment Issue for scope of emissions)

8 The reported impact includes net water consumption from the micro-components utilised by building occupants for sanitary purposes. The impact accounts for water recycling/rainwater collection, where used for permissible non-potable water demands (For further detail refer to BREEAM UK New Construction 2014 Technical Guide (SD5076)).

9 The reported impact is net water consumption i.e. accounts for any water recycling/rainwater collection used to off-set a potable site demand. This KPI is not assessed/reported at the design stage of assessment/certification.

10 The reported impact covers non-hazardous waste from new construction materials, it therefore excludes hazardous and demolition and excavation waste. Where assessed and reported at the design stage of assessment this KPI is based on a target as reported in a compliant Resource Management Plan.

11 The reported impact covers non-hazardous waste from site demolition. Where assessed and reported at the design stage at the design stage of assessment this KPI is based on the target demolition waste diverted from landfill, as reported in a compliant Site Waste Management Plan. If no demolition taking place on site this KPI is not applicable.

12 Where assessed and reported at the design stage of assessment this KPI is based on a target as reported in a compliant Site Waste Management Plan.

13 The reported impact covers the proportion of the key building elements present and assessed by BREEAM that are responsibly sourced. Responsibly sourced and key building elements are defined in the BREEAM UK New Construction 2014 Technical Guide (SD5076).

14 The total volatile organic compound (TVOC) concentration is measured post construction (but pre-occupancy) over 8 hours. Formaldehyde concentration level is measured post construction (but pre-occupancy) averaged over 30 minutes. Both KPI's are measured in accordance with European and/or ISO standards (refer to the BREEAM New Construction Technical Manual for relevant standard numbers). At the design stage of assessment no data is available for this KPI as they are both measured once the building has been constructed (but pre-occupancy) for the purpose of post construction assessment.

"INA" = Indicator Not Assessed. This will be the case where either the data required for the KPI is not gathered/measured by the building's project team or not assessed/quantified in BREEAM for a particular building type or assessment stage e.g. energy consumption for construction process at the design stage of assessment.

"-" = KPI not applicable to building being assessed.

BREEAM UK New Construction 2014 Assessment Report: Assessment Issue Scoring

Building name	The Bedford House
Building score (%)	70.50%
Building rating	Excellent
Minimum standards level achieved	Excellent level

MANAGEMENT

Man 01 Project brief and design

No. of BREEAM credits available	4	Available contribution to overall score	2.29%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Stakeholder consultation (project delivery)	No	1	0
Stakeholder consultation (third party)	Yes	1	1
Sustainabilty champion (design)	Yes	1	1
Sustainabilty champion (monitoring progress)	No	1	0

Total BREEAM credits achieved	2
Total contribution to overall building score	1.14%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	N/A

Assessor comments/notes:

Man 02 Life cycle cost and service life planning

No. of BREEAM credits available	4	Available contribution to overall score	2.29%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

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Assessment Criteria	Compliant?	Credits available	Credits achieved
Elemental life cycle cost (LCC)	No	2	0
Component level LCC plan	No	1	0
Capital cost reporting	No	1	0
Capital cost of the project		£/m²	

Total BREEAM credits achieved	0
Total contribution to overall building score	0.00%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	N/A

Assessor comments/notes:

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Man 03 Responsible construction practices

No. of BREEAM credits available	6	Available contribution to overall score	3.43%
No. of BREEAM innovation credits available	1	Minimum standards applicable	Yes

Assessment Criteria	Compliant?	Credits available	Credits achieved
Is all site timber used in the project 'legally harvested and traded timber'?	Yes		
Environmental Management	Yes	1	1
Construction stage sustainability champion	Yes	1	1
Considerate construction	1	2	1
Monitoring of construction site impact (criterion 8)	Yes		
Utility consumption (water and energy)	Yes	1	1
Transport of construction materials and waste	No	1	0
Exemplary level criteria - considerate construction			

Key Performance Indicators: Construction site energy use

Energy consumption (total) - site processes		Information not available at design stage
Energy consumption (intensity) - site processes		Information not available at design stage
Distance (total) - materials transport to site		Information not available at design stage
Distance (total) -waste transport from site		Information not available at design stage
Energy consumption (total) - materials transport to site		Information not available at design stage
Energy consumption (total) - waste transport from site		Information not available at design stage
Energy consumption (intensity) - materials transport to site		Information not available at design stage
Energy consumption (intensity) - waste transport from site		Information not available at design stage

Key Performance Indicators: Construction site greenhouse gas emissions

Process greenhouse gas emissions (total) - site processes		Information not available at design stage
Greenhouse gas emissions (intensity) - site processes		Information not available at design stage
Greenhouse gas emissions (total) - materials transport to site		Information not available at design stage
Greenhouse gas emissions (total) - waste transport from site		Information not available at design stage
Greenhouse gas emissions (intensity) - materials transport to site		Information not available at design stage
Greenhouse gas emissions (intensity) - waste transport from site		Information not available at design stage

Key Performance Indicators: Construction site use of freshwater resources

Use of freshwater resource (total) - site processes		Information not available at design stage
Use of freshwater resource (intensity) - site processes		Information not available at design stage

Total BREEAM credits achieved	4
Total contribution to overall building score	2.29%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Excellent level

Assessor comments/notes:

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Man 04 Commisioning and handover

No. of BREEAM credits available	4	Available contribution to overall score	2.29%
No. of BREEAM innovation credits available	0	Minimum standards applicable	Yes

Assessment Criteria	Compliant?	Credits available	Credits achieved
Commissioning and testing schedule and responsibilities	Yes	1	1
Commissioning building services	Yes	1	1
Testing and inspecting building fabric	Yes	1	1
Handover - Has a Building User Guide been developed prior to handover?	Yes	1	0
Handover - Has a training schedule been prepared fo building occupiers/managers?	No		

Total BREEAM credits achieved	3
Total contribution to overall building score	1.71%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

Man 05 Aftercare

No. of BREEAM credits available	3	Available contribution to overall score	1.71%
No. of BREEAM innovation credits available	1	Minimum standards applicable	Yes

Assessment Criteria	Compliant?	Credits available	Credits achieved
Aftercare support	Yes	1	1
Seasonal commissioning	Yes	1	1
Post occupancy evaluation	No	1	0
Exemplary level criteria	No	1	0

Total BREEAM credits achieved	2
Total contribution to overall building score	1.14%

Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

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HEALTH & WELLBEING

Hea 01 Visual Comfort

No. of BREEAM credits available	4	Available contribution to overall score	3.53%
No. of BREEAM innovation credits available	1	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Glare control	Yes	1	1
Daylighting (building type dependant)	1	1	1
View out	No	1	0
Internal and external lighting levels, zoning and controls	Yes	1	1
Exemplary level daylighting	No	1	0

Total BREEAM credits achieved	3
Total contribution to overall building score	2.65%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	N/A

Assessor comments/notes:

Hea 02 Indoor Air Quality

No. of BREEAM credits available	5	Available contribution to overall score	4.41%
No. of BREEAM innovation credits available	2	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Indoor air quality (IAQ) plan	Yes	1	1
Ventilation	No	1	0
VOCs (products)	Yes	1	1
VOCs (post-construction)	No	1	0
Adaptability - potential for natural ventilation	No	1	0
Exemplary level VOCs (products)	0	2	0

Key Performance Indicators: Indoor air quality

Concentration levels of formaldehyde		Information not available at design stage
Total volatile organic compound (TVOC) concentration		Information not available at design stage

Total BREEAM credits achieved	2
Total contribution to overall building score	1.76%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	N/A

Assessor comments/notes:

Hea 03 Safe containment in laboratories

Assessment issue not applicable

No. of BREEAM credits available	N/A	Available contribution to overall score	N/A
No. of BREEAM innovation credits available	N/A	Minimum standards applicable	N/A

Assessment Criteria	Compliant?	Credits available	Credits achieved
Objective risk assessment of laboratory facilities			
Laboratory containment devices and containment areas			
Containment level 2 and 3 labs			

Total BREEAM credits achieved	N/A
Total contribution to overall building score	N/A
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Hea 04 Thermal comfort

No. of BREEAM credits available	3	Available contribution to overall score	2.65%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Thermal modelling	Yes	1	1
Adaptability - for a projected climate change scenario	Yes	1	1
Thermal zoning and control	Yes	1	1

Key Performance Indicators	Thermal comfort	Adaptability - for a projected
Predicted Mean Vote (PMV)	INA	
Predicted Percentage Dissatisfied (PPD)	INA	

Total BREEAM credits achieved	3
Total contribution to overall building score	2.65%

Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Hea 05 Acoustic Performance

No. of BREEAM credits available	3	Available contribution to overall score	2.65%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Credits	Credits available	Credits achieved
Acoustic performance standards and testing requirements	2	3	2

Total BREEAM credits achieved	2
Total contribution to overall building score	1.76%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Hea 06 Safety and Security

No. of BREEAM credits available	2	Available contribution to overall score	1.76%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Safe external access	No	1	0
Security of site and building	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	0.88%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

ENERGY

Ene 01 Reduction of energy use and carbon emissions

No. of BREEAM credits available	12	Available contribution to overall score	7.83%
No. of BREEAM innovation credits available	5	Minimum standards applicable	Yes

Ene 01 Calculator

Country of the UK where the building is located	England	Confirm building regulation and version used:	

New Construction (Fully fitted)

Building floor area	530	m2

Notional building heating and cooling energy demand	144.62	MJ/m2 yr
Actual building heating and cooling energy demand	114.84	MJ/m2 yr
Notional building primary energy consumption	49.46	kWh/m2 yr
Actual building primary energy consumption	40.66	kWh/m2 yr
Target emission rate (TER)	14.20	kgCO2/m2 yr
Building emission rate (BER)	10.00	kgCO2/m2 yr
Building emission rate improvement over TER	29.6%	
Heating & cooling demand energy performance ratio (EPR_{DEM})	0.228	
Primary consumption energy performance ratio (EPR_{PC})	0.273	
CO_2 Energy performance ratio (EPR_{CO2})	0.293	
Overall building energy performance ratio (EPR_{NC})	0.794	

Where specified, please confirm the energy production from onsite or near site energy generation technologies	9.26
Equivalent % of the building's 'regulated' energy consumption generated by carbon neutral sources and used to meet energy demand from 'unregulated' building systems or processes?	
Is the building designed to be 'carbon negative' ?	
If the building is defined as 'carbon negative' what is the total (modelled) renewable/carbon neutral energy generated and exported?	

Total BREEAM credits achieved	10
Total contribution to overall building score	6.52%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

Ene 02 Energy monitoring

No. of BREEAM credits available	2	Available contribution to overall score	1.30%
No. of BREEAM innovation credits available	0	Minimum standards applicable	Yes

Assessment criteria	Compliant?	Credits available	Credits achieved
Sub-metering of major energy consuming systems	Yes	1	1
Sub-metering of high energy load and tenancy areas	Yes	1	1

Total BREEAM credits achieved	2
Total contribution to overall building score	1.30%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

Ene 03 External lighting

No. of BREEAM credits available	1	Available contribution to overall score	0.65%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment criteria	Compliant?	Credits available	Credits achieved
External lighting specification	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	0.65%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Ene 04 Low carbon design

No. of BREEAM credits available	3	Available contribution to overall score	1.96%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment criteria	Compliant?	Credits available	Credits achieved
Passive design analysis	Yes	1	1
Free cooling		1	0
Low and zero carbon technologies	Yes	1	1

KPI - Low and/or zero carbon energy generation

Total on-site and/or near-site LZC energy generation	INA	kWh/yr

Total BREEAM credits achieved	2
Total contribution to overall building score	1.30%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Ene 05 Energy efficient cold storage

Assessment issue not applicable

No. of BREEAM credits available	N/A	Available contribution to overall score	N/A
No. of BREEAM innovation credits available	N/A	Minimum standards applicable	N/A

Assessment criteria	Compliant?	Credits available	Credits achieved
Refrigeration energy consumption	Yes	N/A	N/A
Indirect greenhouse gas emissions	Yes	N/A	N/A

Total BREEAM credits achieved	N/A
Total contribution to overall building score	N/A
Total BREEAM innovation credits achieved	N/A

Minimum standard(s) level	N/A

Assessor comments/notes:

Ene 06 Energy efficient transportation systems

No. of BREEAM credits available	3	Available contribution to overall score	1.96%
No. of BREEAM innovation credits available	0	Minimum standards applicable	N/A

Assessment criteria	Compliant?	Credits available	Credits achieved
Energy consumption	Yes	1	1
Energy efficient features	Yes	2	2

Total BREEAM credits achieved	3
Total contribution to overall building score	1.96%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Ene 07 Energy efficient laboratory systems

Assessment issue not applicable

No. of BREEAM credits available	N/A	Available contribution to overall score	N/A
No. of BREEAM innovation credits available	N/A	Minimum standards applicable	N/A

Assessment criteria	Compliant?	Credits available	Credits achieved
Pre-requisite: Criterion 1 of Hea 03 - risk assessment of laboratory facilities			
Design specification			
Best Practice Energy Practices in Laboratories (table 27)			
Item b) Fan power			
Item c) Fume cupboard volume flow rates			
Item d) Grouping / isolation of high filtration/ventilation activities			
Item e) Energy recovery - heat			
Item f) Energy recovery - cooling			
Item g) Grouping of cooling loads			
Item h) Free cooling			
Item i) Load responsiveness			

Item j) Cleanrooms	
Item k) Diversity	
Item l) Room air-change rates	

Total BREEAM credits achieved	N/A
Total contribution to overall building score	N/A
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

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Ene 08 Energy efficient equipment

No. of BREEAM credits available	2	Available contribution to overall score	1.30%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment criteria	Present?	Major impact
Ref A Small power and plug in equipment	Yes	Yes
Ref B Swimming pool	No	
Ref C Communal laundry	No	
Ref D Data centre	No	
Ref E IT-intensive operation areas	No	
Ref F Residential areas	No	
Ref G Healthcare	No	
Ref H Kitchen and catering facilities	No	

	Compliant	Credits available	Credits achieved
Significant majority contributors BREEAM compliant	Yes	2	2

Total BREEAM credits achieved	2
Total contribution to overall building score	1.30%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Ene 09 Drying space

Assessment issue not applicable

No. of BREEAM credits available	N/A	Available contribution to overall score	N/A
No. of BREEAM innovation credits available	N/A	Minimum standards applicable	N/A

Assessment criteria	Compliant?	Credits available	Credits achieved
Residential internal/external drying space and fixings			

Total BREEAM credits achieved	N/A

Total contribution to overall building score	N/A
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

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TRANSPORT

Tra 01 Public Transport Accessibility

No. of BREEAM credits available	3	Available contribution to overall score	3.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Building type category (for purpose of Tra01 issue assessment)	Business (office/industrial)

Assessment Criteria	Compliant	Credits available	Credits achieved
Public transport accessibility index	6.00	3	2
Building dedicated bus service			N/A

Total BREEAM credits achieved	2
Total contribution to overall building score	2.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Tra 02 Proximity to Amenities

No. of BREEAM credits available	1	Available contribution to overall score	1.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Close proximity and accessible to applicable amenities	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	1.00%
Total BREEAM innovation credits achieved	N/A

Minimum standard(s) level	N/A

Assessor comments/notes:

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Tra 03 Cyclist facilities

No. of BREEAM credits available	2	Available contribution to overall score	2.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Building type category (for purpose of Tra03 issue assessment)	Business - (office/Industrial)
Number of compliant cycle storage spaces provided	10
Cyclist facilities provided	Showers only

Assessment Criteria	Compliant?	Credits available	Credits achieved
Cycle storage spaces	Yes	2	2
Cyclist facilities	Yes		

Total BREEAM credits achieved	2
Total contribution to overall building score	2.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Tra 04 Maximum Car Parking Capacity

No. of BREEAM credits available	2	Available contribution to overall score	2.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Building type category (for purpose of Tra04 issue)	Business - (office/Industrial)
Buildings Accessibility Index (sourced from issue Tra01)	6

Assessment Criteria	Compliant?	Credits available	Credits achieved
Maximum parking capacity	Yes	2	1

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Total BREEAM credits achieved	1
Total contribution to overall building score	1.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

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Tra 05 Travel Plan

No. of BREEAM credits available	1	Available contribution to overall score	1.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Transport plan based on site specific travel survey/assessment	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	1.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

WATER

Wat 01 Water Consumption

No. of BREEAM credits available	5	Available contribution to overall score	4.38%
No. of BREEAM innovation credits available	1	Minimum standards applicable	Yes

Please select the calculation procedure used	Alternative approach
	No

Standard approach data

Water Consumption from building micro-components	
Water demand met via greywater/rainwater sources	
Total net water consumption	
Improvement on baseline performance	

Key Performance Indicator - use of freshwater resource

Total net Water Consumption		Indicator not assessed
Default building occupancy		Indicator not assessed

Alternative approach data

Overall microcomponent performance level achieved	Level 3
Please select:	

Total BREEAM credits achieved	3
Total contribution to overall building score	2.63%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

Wat 02 Water Monitoring

No. of BREEAM credits available	1	Available contribution to overall score	0.88%
No. of BREEAM innovation credits available	0	Minimum standards applicable	Yes

Assessment Criteria	Compliant?	Credits available	Credits achieved	
Water meter on the mains water supply to the building(s)	Yes	1	1	N/A
Metering/monitoring equipment on supply to plant/building areas	Yes			
Pulsed output or other open protocol communication output	Yes			
Existing BMS connection	Yes			

Total BREEAM credits achieved	1
Total contribution to overall building score	0.88%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

Wat 03 Water Leak Detection and Prevention

No. of BREEAM credits available	2	Available contribution to overall score	1.75%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Leak detection on building's mains water supply	Yes	1	1
Flow control device to each sanitary area/facility	Yes	1	1

Total BREEAM credits achieved	2
Total contribution to overall building score	1.75%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Wat 04 Water Efficient Equipment

Assessment issue not applicable

No. of BREEAM credits available	N/A	Available contribution to overall score	N/A
No. of BREEAM innovation credits available	N/A	Minimum standards applicable	N/A

Assessment Criteria	Compliant?	Credits available	Credits achieved
Has a meaningful reduction in unregulated water demand been achieved?			

Total BREEAM credits achieved	N/A
Total contribution to overall building score	N/A
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

MATERIALS

Mat 01 Life Cycle Impacts

No. of BREEAM credits available	5	Available contribution to overall score	5.19%
No. of BREEAM innovation credits available	3	Minimum standards applicable	No

Assessment Criteria

Total Mat01 credits achieved	4
Total Mat01 points achieved	17.88
Number of building elements assessed	6
Exemplary level compliant?	Yes
Has IMPACT compliant software been used?	No

Key Performance Indicator - embodied green house gas emissions by element	Total area of element m^2	Total impact $kgCO_2$ eq.	Area of element impact data relevant to m^2
External walls	646	36618	646

Windows	124	13640	124
Roof	660	40260	660
Upper floor construction	415	-1743	415
Internal wall	776	12004	776
Floor finishes/coverings	954.8	46123.7	954.8

Key Performance Indicator - embodied green house gas emissions for building (assessed elements only)

Total embodied green house gas emissions for building (by assessed elements)	146902.7	$kgCO_2$ eq.	277.17	$kgCO_2$ eq./m^2
Proportion of applicable building elements that data reported covers	100%			

Total BREEAM credits achieved	4
Total contribution to overall building score	4.15%
Total BREEAM innovation credits achieved	1
Minimum standard(s) level	N/A

Assessor comments/notes:

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Mat 02 Hard Landscaping and Boundary Protection

No. of BREEAM credits available	1	Available contribution to overall score	1.04%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
External hard landscaping and boundary protection	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	1.04%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Mat 03 Responsible Sourcing

No. of BREEAM credits available	4	Available contribution to overall score	4.15%
No. of BREEAM innovation credits available	1	Minimum standards applicable	Yes

Assessment Criteria	Compliant	Credits available	Credits achieved
All timber and timber based products are 'Legally harvested and trader timber'	Yes		
Is there a documented sustainable procurement plan	Yes	1	1
Percentage of available responsible sourcing of materials points achieved		3	0

Please confirm the route used to assess Mat03	Please select

Total BREEAM credits achieved	1
Total contribution to overall building score	1.04%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

Mat 04 Insulation

No. of BREEAM credits available	1	Available contribution to overall score	1.04%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria		Credits available	Credits achieved
Embodied impact - insulation index	2.50	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	1.04%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Mat 05 Designing for durability and resilience

No. of BREEAM credits available	1	Available contribution to overall score	1.04%
No. of BREEAM innovation credits available	0	Minimum standards applicable	N/A

Assessment Criteria	Compliant?	Credits available	Credits achieved
Protecting vulnerable parts of the building from damage	Yes	1	1
Protecting exposed parts of the building from material degradation	Yes		

Total BREEAM credits achieved	1
Total contribution to overall building score	1.04%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Mat 06 Material efficiency

No. of BREEAM credits available	1	Available contribution to overall score	1.04%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Material optimisation measures investigated and implemented at relevant stages	No	1	0

Total BREEAM credits achieved	0
Total contribution to overall building score	0.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

WASTE

Wst 01 Construction Waste Management

No. of BREEAM credits available	4	Available contribution to overall score	3.78%
No. of BREEAM innovation credits available	1	Minimum standards applicable	Yes

Assessment Criteria	Compliant?
Construction resource management plan	Yes
Compliant Pre-demolition audit	N/A
Does the excavation waste meet the exemplary level requirements?	N/A

Key Performance Indicators - Construction Waste

Measure/units for the data being reported	tonnes		
Non-hazardous construction waste (excluding demolition/excavation)	3.00	tonnes/100m2	Note: If data not available then insert
Total non-hazardous construction waste generated	15.90	tonnes	Note: At the design stage of assessme
Non-hazardous non-demolition const. waste diverted from landfill		%	Note: At the design stage this will be a
Total non-hazardous non-demolition const. waste diverted from landfill	INA	tonnes	Note: At the design stage of assessme
Total non-hazardous demolition waste generated		Indicator not applic	
Non-hazardous demolition waste diverted from landfill		Indicator not applic	
Total non-hazardous demolition waste to disposal		Indicator not applic	
Material for reuse		tonnes	
Material for recycling		tonnes	
Material for energy recovery		tonnes	
Hazardous waste to disposal		tonnes	

Total BREEAM credits achieved	3
Total contribution to overall building score	2.83%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

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Wst 02 Recycled Aggregates

No. of BREEAM credits available	1	Available contribution to overall score	0.94%
No. of BREEAM innovation credits available	1	Minimum standards applicable	No

Assessment Criteria	Total
Total % of high-grade aggregate that is recycled/secondary aggregate	0%

% of high-grade aggregate that is recycled/secondary aggregate - by application

Structural frame	
Bitumen/hydraulically bound base, binder and surface courses	
Building foundations	
Concrete road surfaces	
Pipe bedding	
Granular fill and capping	

Total BREEAM credits achieved	0
Total contribution to overall building score	0.00%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	N/A

Assessor comments/notes:

Wst 03 Operational Waste

No. of BREEAM credits available	1	Available contribution to overall score	0.94%
No. of BREEAM innovation credits available	0	Minimum standards applicable	Yes

Assessment Criteria	Compliant?	Credits available	Credits achieved
Segregation and storage of operational recyclable waste volumes	Yes	1	1
Static waste compactor(s) or baler(s)	N/A		
Vessel(s) for composting suitable organic waste	N/A		

Total BREEAM credits achieved	1
Total contribution to overall building score	0.94%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

Wst 04 Speculative Floor and Ceiling Finishes

No. of BREEAM credits available	1	Available contribution to overall score	0.94%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
The building's occupant(s)/tenant(s) have specified floor/ceiling finishes	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	0.94%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Wst 05 Adaption to climate change

No. of BREEAM credits available	1	Available contribution to overall score	0.94%
No. of BREEAM innovation credits available	1	Minimum standards applicable	N/A

Assessment Criteria	Compliant?	Credits available	Credits achieved
Adaption to climate change - structural and fabric resilience	Yes	1	1
Exemplary level - responding to adaptation to climate change	No	1	0

Total BREEAM credits achieved	1
Total contribution to overall building score	0.94%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	N/A

Assessor comments/notes:

Wst 06 Functional adaptability

No. of BREEAM credits available	1	Available contribution to overall score	0.94%
No. of BREEAM innovation credits available	0	Minimum standards applicable	N/A

Assessment Criteria	Compliant?	Credits available	Credits achieved
Functional adaptability	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	0.94%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

LAND USE & ECOLOGY

LE 01 Site Selection

No. of BREEAM credits available	2	Available contribution to overall score	2.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

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Assessment Criteria	Compliant?	Credits available	Credits achieved
Previously occupied land	Yes	1	1
Contaminated land	No	1	0

Total BREEAM credits achieved	1
Total contribution to overall building score	1.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

LE 02 Ecological Value of Site and Protection of Ecological Features

No. of BREEAM credits available	2	Available contribution to overall score	2.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Ecological value of the land defined using	A Suitably Qualified Ecologist

Assessment Criteria

	Compliant?	Credits available	Credits achieved
Land of low ecological value	Yes	1	1
Protection of ecological features	Yes	1	1

Total BREEAM credits achieved	2
Total contribution to overall building score	2.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

LE 03 Mitigating Ecological Impact

No. of BREEAM credits available	2	Available contribution to overall score	2.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	Yes

Data sourced for calculating the change in ecological value from	Suitably Qualified Ecologist site survey of plant species

Assessment Criteria

Change in ecological value	6.00	Plant species richness

Total BREEAM credits achieved	2
Total contribution to overall building score	2.00%

Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	Outstanding level

Assessor comments/notes:

LE 04 Enhancing Site Ecology

No. of BREEAM credits available	2	Available contribution to overall score	2.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Suitably Qualified Ecologist appointment (SQE)	Yes	2	1
Ecologist's report and recommendations	Yes		
Increase in ecological value	1	Plant species richness	

Total BREEAM credits achieved	1
Total contribution to overall building score	1.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

LE 05 Long Term Impact on Biodiversity

No. of BREEAM credits available	2	Available contribution to overall score	2.00%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Suitably qualified ecologist (SQE) appointed	Yes	2	2
Landscape and habitat management plan	N/A		
Number of applicable measures			
Number of applicable measures implemented			

Total BREEAM credits achieved	2
Total contribution to overall building score	2.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

POLLUTION

Pol 01 Impact of Refrigerants

No. of BREEAM credits available	3	Available contribution to overall score	2.31%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria

		Credits available	Credits achieved
Refrigerant containing systems installed in the assessed building?	Yes	2	0
BS EN 378:2008 and IoR Ammonia Refrigeration Systems CoP (where applicable)?	Yes		
Global Warming Potential of the specified refrigerant(s) 10 or less?	No		
Total Direct Effect Life Cycle CO_2eq. emissions from the system		kgCO2eq/kW coolth capacity	
Cooling/Heating capacity of the system		kW	
BREEAM compliant refrigerant leak detection and containment	No	1	0

Total BREEAM credits achieved	0
Total contribution to overall building score	0.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Pol 02 NO_x Emissions

No. of BREEAM credits available	3	Available contribution to overall score	2.31%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria

NO_x emission level - space heating	40.00	mg/kWh
NO_x emission level - cooling	0.00	mg/kWh
NOx emission level - water heating		mg/kWh
Does this building meet BREEAM's definition of a highly insulated building?	Yes	

Energy consumption: heating and hot water		kWh/m2 yr

Total BREEAM credits achieved	1
Total contribution to overall building score	0.77%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

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Pol 03 Surface Water Run off

No. of BREEAM credits available	5	Available contribution to overall score	3.85%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Annual probability of flooding	Low	2	2
Flood Risk Assessment	Yes		
Surface water run off – peak rate	Yes	1	1
Surface water run off – volume, attenuation and/or limiting discharge	Yes	1	1
Minimising watercourse pollution	No	1	0

Total BREEAM credits achieved	4
Total contribution to overall building score	3.08%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

Pol 04 Reduction of Night Time Light Pollution

No. of BREEAM credits available	1	Available contribution to overall score	0.77%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
External lighting specification	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	0.77%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

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Pol 05 Noise Attenuation

No. of BREEAM credits available	1	Available contribution to overall score	0.77%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment Criteria	Compliant	Credits available	Credits achieved
Noise-sensitive areas/buildings within 800m radius of the development	Yes	1	1
Noise impact assessment and, if applicable, noise attenuation measures	Yes		

Total BREEAM credits achieved	1
Total contribution to overall building score	0.77%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Assessor comments/notes:

INNOVATION

Inn 01 Innovation

No. of BREEAM innovation credits available	10	Available contribution to overall score	10.00%
		Minimum standards applicable	No

Assessment Criteria	Compliant?	Credits available	Credits achieved
Man 03 Responsible construction practices	No	1	0
Man 05 Aftercare	No	1	0
Hea 01 Visual Comfort	No	1	0
Hea 02 Indoor Air Quality	No	2	0
Ene 01 Reduction of energy use and carbon emissions	No	5	0
Wat 01 Water Consumption	No	1	0
Mat01 Life Cycle Impacts	Yes	3	1
Mat03 Responsible Sourcing of Materials	No	1	0
Wst01 Construction Waste Management	No	1	0
Wst02 Recycled Aggregates	No	1	0

Wst 05 Adaption to climate change	No	1	0

Number of 'approved' innovation credits achieved?	

Total BREEAM innovation credits achieved	1
Total contribution to overall building score	1.00%
Minimum standard(s) level	N/A

Assessor comments/notes: