SYNTEGRA CONSULTING

16-2280

Energy Strategy Report

Informer House, Teddington, TW11 8EW

June 2016

Quality Standards Control

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1. Executive Summary

The design of the proposed development at **2 High Street, Teddington, TW11 8EW** will be comprised of the **new construction of 23 flats and a commercial unit.** The design has incorporated building fabric enhancement (above current building regulations requirements) to increase the energy efficiency of the building. This includes that the development uses less energy, by adopting sustainable design and construction measures and by supplying energy efficiently.

The **London Borough of Richmond Upon Thames** Council requires all proposed developments to incorporate sustainable design and construction measures. The Council will promote and measure sustainable design and construction by expecting **all new developments to achieve an overall 35% reduction of CO_2 emissions over the Building Regulations Part L 2013 and BREEAM NC 2014 'Excellent' for the commercial unit as per the Local Policy DM SD1. This requirement includes 20% carbon reduction through on-site renewables in accordance with the Local Policy CP2.**

The recommendation for the proposed development is **to achieve U-values and air permeability better than Building Regulations Part L1A/2A; to install high efficiency electric room heaters and hot water systems for residential units; to install high efficiency room heaters by Air Source Heat Pumps (COP 4.2) for the commercial unit; to equip Mechanical Ventilation with Heat Recovery (MVHR) for residential units; to use Accredited Construction Details for all thermal bridging junctions; to install low energy lights; and to allocate 37.8 kWp PV on the roof.** This is based on the following reasons:

1. The strategy would provide an average of **36% CO_2 reduction saving (DER/TER) against Building Regulations Part L 2013 baseline.** Therefore, the strategy meets requirements of the London Plan policies and Local policies.

2. The following hierarchy of the Mayor's Energy Strategy has been explored and implemented:
    - BE LEAN: Energy efficient design
    - BE CLEAN: Connection to district heat networks or communal heating systems
    - BE GREEN: Installation of on-site renewable energy technologies

3. At BE LEAN stage, **energy efficient measures** (high performance building fabric, efficient heating and hot water systems, Accredited Construction Details, low energy lights, and efficient ventilation systems) were suggested, and would provide about 2% carbon reduction.

4. At BE GREEN stage, **PV panels of 37.8 kWp** were proposed for the whole development, and would provide a 35% carbon reduction. The PV panels would be located on the roof areas (approximately 120 panels with 315 w/p are required).

5. **The pre-assessment for BREEAM New Construction (2014)** has been undertaken for the commercial unit demonstrating that an **"Excellent"** rating can be achieved [See the Appendix for the pre-assessment report].

After the application of the Energy Hierarchy, the regulated carbon dioxide emissions and savings are presented on the table below:

Energy Hierarchy	Strategies	Regulated Carbon Emissions (Tonnes CO_2/yr.)
BASELINE	TER set by Building Regulations 2013 Part L	46.15
BE LEAN	After energy demand reduction	45.31
BE CLEAN	After CHP/ Communal Heating	45.31
BE GREEN	After renewable energy	29.44

Table 1 Carbon Emissions after each stage of the proposed strategy

The chart below summarizes the regulated carbon dioxide savings from each stage of the proposed strategy:

Energy Hierarchy	Strategies	Regulated Carbon Savings	
		Tonnes CO_2/yr.	**%**
BE LEAN	After energy demand reduction	0.84	1.82 %
BE CLEAN	After CHP/ Communal Heating	-	-
BE GREEN	After renewable energy	15.87	35.02 %
Total Cumulative Savings		**16.71**	**36%**
Total Target Savings		16.15	35 %

Table 2 Carbon dioxide Emissions after each stage of the Energy Hierarchy

Figure below illustrates the hierarchical approach adopted and the resultant reduction in overall CO_2 emissions.

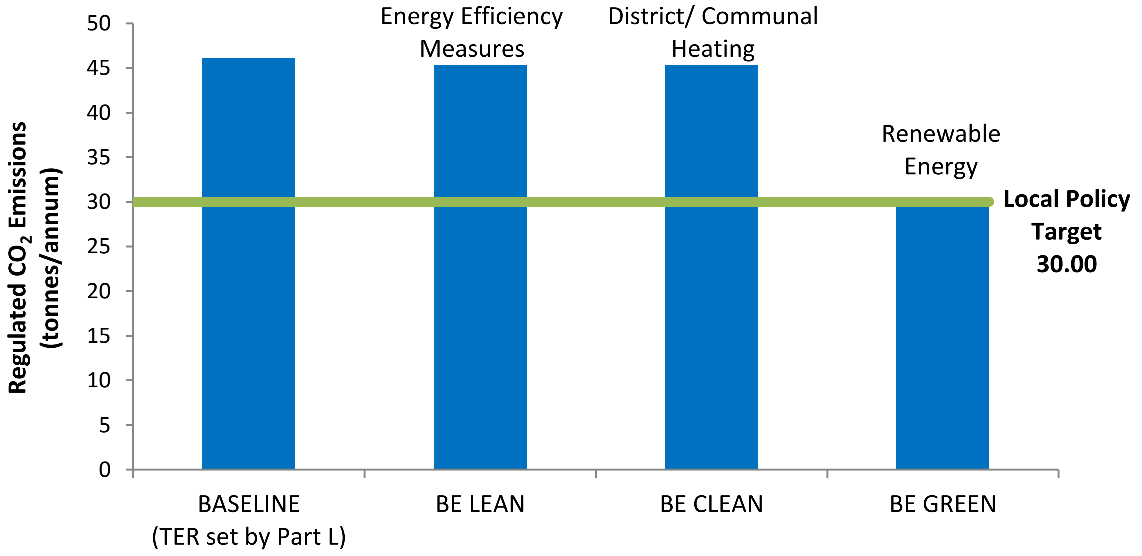


Figure 1 Carbon Emissions in Energy Hierarchy

2. Introduction

Syntegra Consulting Ltd has been appointed as sustainability consultants to produce an energy strategy for **new construction of 23 flats and a commercial unit at 2 High Street, Teddington, TW11 8EW.** To support the scheme design process, this report demonstrates Building Regulations Part L 2013 compliance and an **overall 35% reduction of CO_2 emissions** over 2013 Building Regulations in accordance with the London Plan and Local planning policy requirements.

This report will outline the following:

1) This report will assess the proposed development site's estimated energy demand & CO_2 emissions. It will look into the feasibility of Low Zero Carbon technologies, examining the following aspects relative to LZC/renewable technologies:

- Energy generated by Renewable/Low Zero Carbon Technologies (LZC)
- Feasibility assessment for each Renewable/Low Zero Carbon Technologies (LZC)
- Local Planning Requirements
- Life cycle Costs & payback period for the technology investment
- Available Grants

2) The proposed building fabric and Low Zero Carbon (LZC) design strategy and analysis calculations, with respect to the Standard Assessment energy assessment Procedure (SAP). Demonstration of how the design is compliant against the current Part L 2013 building regulations and the local policy requirements i.e. **A 35% CO_2 emission reduction with 20% against the Target Emission Rate (TER) set by Building Regulations Part L 2013.**

3) **The 20% reduction** of the development's CO2 emissions through **the utilisation of onsite renewable technology** as per the planning policy requirements.

4) **BREEAM NC 2014 pre-assessment strategy to achieve 'Excellent' for the commercial unit** in the development.

5) Assessment of opportunities for utilising Decentralised Energy Networks and Combined Heat and Power (CHP) as per the planning policy requirements.

3. Site Description

The proposed development will be comprised of the **new construction of new construction of 23 flats and 1 commercial unit.** The development is located in the **London Borough of Richmond Upon Thames** and it is in close proximity to Teddington Station (approximately 0.2 miles to the South) and Teddington Library (approximately 450ft to the North).

4. Planning Policy

4.1. National Planning Policy Framework (March 2012)

The National Planning Policy Framework is a key part of our reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth.

4.2. The London Plan Renewable Energy Policy 2015 (Policy 5.2, 5.6, 5.7 & 5.9)

The Mayor and boroughs should in their DPDs adopt a presumption that developments will achieve a reduction in carbon dioxide emissions of 20% from onsite renewable energy generation according to paragraph 5.42 of Policy 5.7 Renewable Energy (which can include sources of decentralised renewable energy). According to Policy 5.2 (clause B) all major residential and non-residential buildings should show an improvement of 40% BER/TER from 2013 to 2016 over 2010 Building Regulations, unless it can be demonstrated that such provision is not feasible. Furthermore, intent must be shown for connecting to a Decentralised Energy Network and utilizing a Combined Heat & Power according to Policy 5.6 and reducing the potential for overheating and reliance on air conditioning systems according to Policy 5.9.

4.3. London Borough of Richmond Upon Thames

LONDON BOROUGH OF RICHMOND UPON THAMES

<u>**Core Strategy** (Adopted in April 2009)</u>

CP1 - Sustainable Development

1.A The policy seeks to maximise the effective use of resources including land, water and energy, and assist in reducing any long term adverse environmental impacts of development. Development will be required to conform to the Sustainable Construction checklist, including the requirement to meet the Code for Sustainable Homes level 3 (for new homes), Ecohomes “excellent” (for conversions) or BREEAM “excellent” for other types of development. This requirement will be adjusted in future years through subsequent DPDs, to take into account the then prevailing standards in the Code for

Sustainable Homes and any other National Guidance, and ensure that these standards are met or exceeded.

CP2 - Reducing Carbon Emissions

2.A The Borough will reduce its carbon dioxide emissions by requiring measures that minimise energy consumption in new development and promoting these measures in existing development, particularly in its own buildings.

2.B The Council will require the evaluation, development and use of decentralised energy in appropriate development.

2.C The Council will increase the use of renewable energy by requiring all new development to achieve **a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation** unless it can be demonstrated that such provision is not feasible, and by promoting its use in existing development.

Development Management Plan (Adopted November 2011)

Policy DM SD 1 - Sustainable Construction

All development in terms of materials, design, landscaping, standard of construction and operation should include measures capable of mitigating and adapting to climate change to meet future needs.

New buildings should be flexible to respond to future social, technological and economic needs by conforming to the Borough's Sustainable Construction Checklist SPD.

New homes will be required to meet or requirements of the Code for Sustainable Homes Level 3.

They also must achieve a minimum 25 per cent reduction in carbon dioxide emissions over Building Regulations (2010) in line with best practice from 2010 to 2013, **40 percent improvement from 2013 to 2016**, and 'zero carbon' standards from 2016. It is expected that efficiency measures will be prioritised as a means towards meeting these targets. These requirements may be adjusted in future years to take into account the then prevailing standards and any other national guidance to ensure the standards are met or exceeded.

New non-residential buildings over 100sqm will be required to meet the relevant BREEAM 'excellent' standards. For conversions see Policy DM SD 3 'Retrofitting'.

Policy DM SD 2 - Renewable Energy and Decentralised Energy Networks

New development will be required to conform with the Sustainable Construction Checklist SPD and:

(a) Maximise opportunities for the micro-generation of renewable energy. Some form of low carbon renewable and/or de-centralised energy will be expected in all new development, and
(b) Developments of 1 dwelling unit or more, or 100sqm of non-residential floor space or more will be required to reduce their total carbon dioxide emissions by following a hierarchy that first requires and efficient design to minimize the amount of energy used, secondly, by using low carbon technologies and finally, where feasible and viable, including a contribution from

renewable sources.

(c) Local opportunities to contribute towards decentralized energy supply from renewable and low-carbon technologies will be encouraged where there is no over-riding adverse local impact.

(d) All new development will be required to connect to existing or planned decentralized energy networks where one exists. In all major developments and large Proposals Sites Identified in the (forthcoming) Site Allocations DPD, provision should be made for future connection to a local energy network should one become available.

NB: The Code for Sustainable Homes Scheme has now been removed from national policy, therefore a CfSH pre-assessment has not been produced for this report.

4.4. The Energy Hierarchy

The Mayor's Energy Strategy adopts a set of principles to guide design development and decisions regarding energy, balanced with the need to optimise environmental and economic benefits. These guiding principles have been reordered since the publication of the Mayor's Energy Strategy in Feb 2004 and the adopted replacement London Plan 2011 with further alterations in 2015 states that 'The following hierarchy should be used to assess applications:

- *Using less energy, in particular by adopting sustainable design and construction measures;*
- *Supplying energy efficiency, in particular by prioritising decentralised energy generation; and*
- *Using renewable energy.*

The development's Energy Strategy has adopted the following design ethos:

- ✓ **BE LEAN** – By using less energy and taking into account the further energy efficiency measure in comparison to the baseline building.
- ✓ **BE CLEAN** – By supplying energy efficiently. The clean building looks at further carbon dioxide emission savings over the lean building by taking into consideration the use of decentralise energy via CHP.
- ✓ **BE GREEN** – By integrating renewable energy into the scheme which can further reduce the carbon dioxide emission rate.

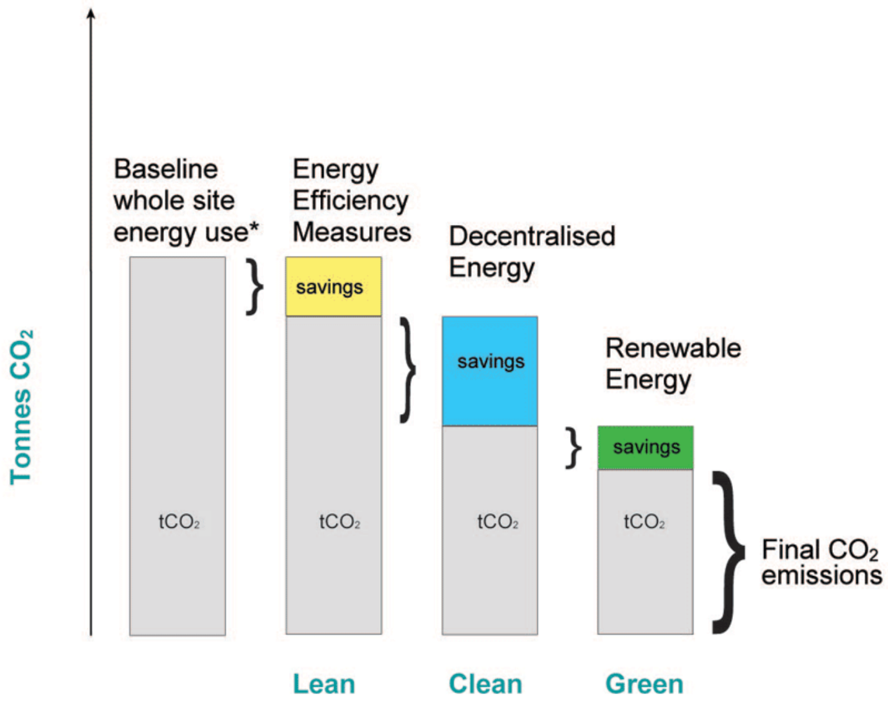


Figure 2 The Energy Hierarchy

5. Input data for energy assessment

Syntegra received the architectural drawings and relevant documents, and they were used to undertaken the energy assessments i.e. SAP and SBEM calculations. The drawing and document references are listed in table below.

No.	Document Name	Drawing No.	Received Date
1	Proposed Lower Ground Floor Plan	WP-0410-GA-P-LB	22-04-2016
2	Proposed Ground Floor Plan	WP-0410-GA-P-L0	22-04-2016
3	Proposed First Floor Plan	WP-0410-GA-P-L1	22-04-2016
4	Proposed Second Floor Plan	WP-0410-GA-P-L2	22-04-2016
5	Proposed Third Floor Plan	WP-0410-GA-P-L3	22-04-2016
6	Proposed Fourth Floor Plan	WP-0410-GA-P-L4	22-04-2016
7	Proposed L5 Floor Plan	WP-0410-GA-P-L5	22-04-2016
8	Proposed Roof Plan	WP-0410-GA-P-LR	22-04-2016
9	Proposed East Elevation	WP-0410-GA-E-EAST	27-04-2016
10	Proposed North Elevation	WP-0410-GA-E-NORTH	27-04-2016
11	Proposed South Elevation	WP-0410-GA-E-SOUTH	27-04-2016
12	Proposed Section AA	WP-0410-GA-S-AA	27-04-2016
13	Proposed Section BB	WP-0410-GA-S-BB	27-04-2016

Table 3 The drawing list

5.1. The Unit Configuration

The following table presents the type, area and number of units to be assessed within this report:

NEW CONSTRUCTION				
Type	**Name of unit**	**Floor**	**No. of Bedrooms**	**Net Floor Area** (m^2)
Residential	Flat 1 – Type 1A facing South	1st	1	51
	Flat 2 – Type 1A facing North	1st	1	51
	Flat 3 – Type 1B	1st	1	51
	Flat 4 – Type 2A	1st	2	65
	Flat 5 – Type 2WAU	1st	2	77
	Flat 6 – Type 1A facing South	2nd	1	51
	Flat 7 – Type 1A facing North	2nd	1	51
	Flat 8 – Type 1B	2nd	1	51
	Flat 9 – Type 2A	2nd	2	65
	Flat 10 – Type 2WAU	2nd	2	77
	Flat 11 – Type 1A facing South	3rd	1	51
	Flat 12 – Type 1B	3rd	1	51
	Flat 13 – Type 2A	3rd	2	65

	Flat 14 – Type 2B	3rd	2	62
	Flat 15 – Type 3C	3rd	2	64
	Flat 16 – Type 1A facing South	4th	1	51
	Flat 17 – Type 1B	4th	1	51
	Flat 18 – Type 2A	4th	2	65
	Flat 19 – Type 2B on the top	4th	2	62
	Flat 20 – Type 2C on the top	4th	2	64
	Flat 21 - Type 1A facing South on the top	5th	1	51
	Flat 22 – Type 2A on the top	5th	2	65
	Flat 23 – Type 1B on the top	5th	1	55
Non-residential	Commercial Unit	Ground	-	301
Total	**-**	**-**	-	**1,644**

Table 4 Proposed units to be assessed for the development

5.2. Specification of Building Elements

The table presented below demonstrates the material properties of the building fabric that have been proposed:

Building Elements		Proposed Specification
U-value (W/m² K)	**External Walls**	0.13
	Window units	1.2 (g value of 0.8)
	Floor	0.12
	Roof	0.12
	Door	1.0
Air Permeability ($m^3/h.m^2$ at 50 Pa)		3.5
Thermal Bridging		Accredited Construction Details for Part L 2013 (http://www.planningportal.gov.uk/buildingregulations/approveddocuments/partl/bcassociateddocuments9/acd)
Lighting	**Residential**	100 % Low energy lights (e.g. LED)
	Commercial	80 Lumens/Watt with output ratio 0.7 (35l/m for display lighting)
Heating system	**Residential**	Electric Room Heaters – panels/ convector/ radiant heaters
	Commercial	Room Heaters by ASHPs (COP 4.2)
Hot water system		Electric immersion with 250 litres cylinder (Daily loss factor 1.7 kWh)
Ventilation	**Residential**	Mechanical Ventilation with Heat Recovery
	Commercial	Natural Ventilation with extract fans in wet rooms

Table 5. Building envelop specification

5.3. Fuel

The assessment has assumed the following fuel carbon emissions factors. The fuel carbon emissions factors used are in accordance with SAP and SBEM calculations (for Building Regulations Part L1A and L2A 2013).

Carbon Emissions Factor	SAP 2013 kgCO2/kW	SBEM 2013 kgCO2/kW
Natural Gas	0.216	0.216
LPG	0.241	0.241
Biogas	0.098	0.098
Heating Oil	0.298	0.319
Coal (traditional British Coal)	0.394	0.345
Anthracite	0.394	0.394
Smokeless fuel	0.433	0.433
Dual Fuel (mineral + wood)	0.226	0.226
Biomass	0.123	0.031
Grid Electricity	0.519	0.519
Waste Heat	0.058	0.058

Table 6. Carbon emission factors

6. Baseline CO_2 Emissions

The baseline energy use and resulting CO_2 emissions rates of the development have been assessed using the Government approved software, i.e. IES VE 2015. The calculations have been produced according to the Part L 2013 Building Regulation requirements.

For the purpose of this report the baseline energy use and CO_2 emissions for the development are calculated by the SAP and SBEM methodologies based on the minimum requirements specified in the Building Regulations L1A and L2A 2013 document (See table below).

		Part L 2013 min. required values	
		L1A	**L2A**
U-value (W/m^2 K)	Wall	0.30	0.35
	Window	2.00	2.20
	Floor	0.25	
	Roof	0.20	0.25
	Door	1.0 (notional)	1.5 - 2.2
Air Permeability (m^3/h.m^2 at 50 Pa)		10	

Table 7 Required Values in Building Regulations Part L 2013

The baseline average energy use and CO_2 emissions for the development as a whole are presented in the tables below:

BASELINE

BASELINE: TER	Regulated CO_2 Emissions	
	kg CO_2/m^2/yr.	Tonnes CO_2/ yr.
Residential	26.79	35.98
Non-Residential	33.80	10.17
TOTAL	**60.59**	**46.15**

Table 8 Regulated Carbon Emissions at Baseline

7. BE LEAN – Energy Efficient Design

This section outlines the design energy efficient measures taken in order to minimise the building's energy demand and therefore reduce energy use and CO_2 emissions further than the Baseline (Building Regulations 2013 Part L compliance).

The energy efficient measures include:

1. Inclusion of better U-values than the minimum U-values set in the Part L 2013 document.
2. Designing for a buildings air permeability meeting Part L 2013 target values.
3. Using Accredited Construction Details for all thermal bridging junctions.
4. Introducing natural ventilation to reduce CO_2 emissions due to mechanical ventilation
5. Utilising low energy efficient lighting such as LED lighting.

7.1. Efficient Building elements

At the 'BE LEAN' stage of the energy hierarchy, energy efficient building elements have been incorporated into the build. Please see below more specifically:

		Part L 2013 min. required values		Proposed building values
		L1A	L2A	
U-value (W/m^2 K)	Wall	0.30	0.35	0.13
	Window	2.00	2.20	1.2
	Floor	0.25		0.12
	Roof	0.20	0.25	0.12
	Door	1.0 (notional)	1.5 -2.2	1.0
Air Permeability (m^3/h.m^2 at 50 Pa)		10		3.5

Table 9 Proposed Building Elements

7.1. Heating and Hot water demand

The heating energy demand will be reduced by providing good insulation of the building envelope in order to minimise heat losses. At the 'BE LEAN' stage, **High efficiency electric room heaters for the residential units and room heaters by Air Source Heat Pumps (COP 4.2) for the commercial unit** have been examined. The heating system for the residential areas are controlled by programmer and room thermostats. And, the heating for the commercial unit is controlled by central time, local time, and local temperature. Ductwork and AHU leakage levels are Class A and Class L1 set by CEN classification. **For hot water demand, electric immersion system** has been examined for the residential units. The cylinder of 250 litres with 1.7 kWh/day has been considered for each flat. **For the commercial unit, electric instantaneous at point of use** has been examined.

All specifications above are provisional suggestions at this early design stage, and therefore have to be closely reviewed with mechanical engineers at detailed design stage.

7.2. Ventilation

- **Residential units - Mechanical Ventilation with Heat Recovery (MVHR) will be equipped** to reduce heat losses from the internal areas. At this early design stage, Greenwood MVHR 90R has been used to calculate energy demand and carbon emission. However, the specific product and its specifications should be reviewed by mechanical engineers at detailed design stage.

- **Commercial unit - A natural ventilation strategy will be adopted with extract fans in wet rooms**; toilets, kitchen, and utility rooms etc. Therefore, higher energy consumption and CO2 emissions due to mechanical ventilation is avoided.

7.3. Lighting

The proposed light fittings will be low energy efficient fittings. These can be **T5 fluorescent fittings with high frequency ballasts, or LED fittings for residential units. For the non-residential areas, lighting efficiency of 80 Lumens/ Circuit Watt with output ratio 0.7 (35lm/W for display lighting)** was considered at this early design stage. The suggested specifications should be reviewed at detailed design stage with electric engineers.

The following tables demonstrate the reduction in CO_2 emissions caused by the energy efficiency measures mentioned above.

BE LEAN STAGE

		Regulated CO_2 Emissions		
		BASELINE	**BE LEAN**	**Reduction**
Residential	**kg CO_2/m^2/yr.**	**26.79**	**26.43**	**-**
	Tonnes CO_2/ yr.	**35.98**	**35.50**	**1.34 %**
Non-Residential	**kg CO_2/m^2/yr.**	**33.80**	**32.60**	**-**
	Tonnes CO_2/ yr.	**10.17**	**9.81**	**3.55%**
TOTAL	**kg CO_2/m^2/yr.**	**60.59**	**59.03**	**-**
	Tonnes CO_2/ yr.	**46.15**	**45.31**	**1.82 %**

Table 10 Regulated Carbon Reduction at Be Lean Stage

From the table above it can be seen that the overall CO_2 reduction due to energy efficiency measure is ***1.82 %*** for the total emissions.

8. BE CLEAN – CHP & Decentralised Energy Networks

The Energy Hierarchy encourages the use of a CHP system and the connection to District Heating system to reduce CO_2 emissions further.

8.1. CHP

The Energy Hierarchy identifies the combined heat and power (CHP) as a method of producing heat and electricity with much lower emissions than separate heat and power. Also, it encourages the creation of district heating systems supplied by CHP.
The implementation of a CHP strategy should be decided according to good practice design. Key factors for the efficient implementation of the CHP system are:

- Development with high heating load for the majority of the year.
- CHP operation based on maximum heat load for minimum 10 hours per day.
- CHP operation at maximum capacity of 90% of its operating period.

To ensure that CHP is financially viable it is essential that the unit is selected to meet the base heat load and that this load is maintained over a large proportion of the day (a figure of 14 – 17 hours per day is often quoted subject to the load profiles and gas and electricity prices) to ensure that the additional costs (maintenance) associated with running a CHP unit can be recovered.

This need to run the CHP plant, as far as possible continuously makes the building load profile of prime importance when reviewing the viability of such solutions and in particular the summer time heat load profile. CHP systems only make financial sense to operate when the waste heat associated with generating the electricity is usefully used. To enable the CHP plant to run continuously when it is operating, a thermal store is often used so that excess CHP capacity can be used to generate hot water for use at a later time.

The load profile for this kind of development is intermittent. Hence a CHP system has not been considered for this development

8.2. Micro-CHP

Micro CHP has not been considered further for this project due to the following reasons:
Micro-CHP is a relatively new concept and issues are raised in relation to unproven technology, inefficiency for shorter run cycles and lack of technical knowledge that can limit the practical application of micro CHP at present. In addition, high installation costs and estimated low life expectancy has also been taken into consideration as to its Commercial unit's un-viability for this development scheme. Micro-CHP also has lower FIT tariff rate and period duration and is only applicable for systems under 2kW.

8.3. Decentralised Energy Network

The **Mayor's Energy Strategy** favours community heating systems because they offer:

- ✓ Potential economies of scale in respect of efficiency and therefore reduced carbon emissions; and
- ✓ Greater potential for future replacement with Low or Zero Carbon (LZC) technologies.

The feasibility of connecting into an existing heating network or providing the building with its own combined heat and power plant has been assessed alongside the **London Heat Map Study for the London Borough of Richmond Upon Thames** as part of this assessment. The study identifies that the site is not located near the existing and potential district heating networks. This is demonstrated clearly from the London Heat Map (http://www.londonheatmap.org.uk) snapshot below.

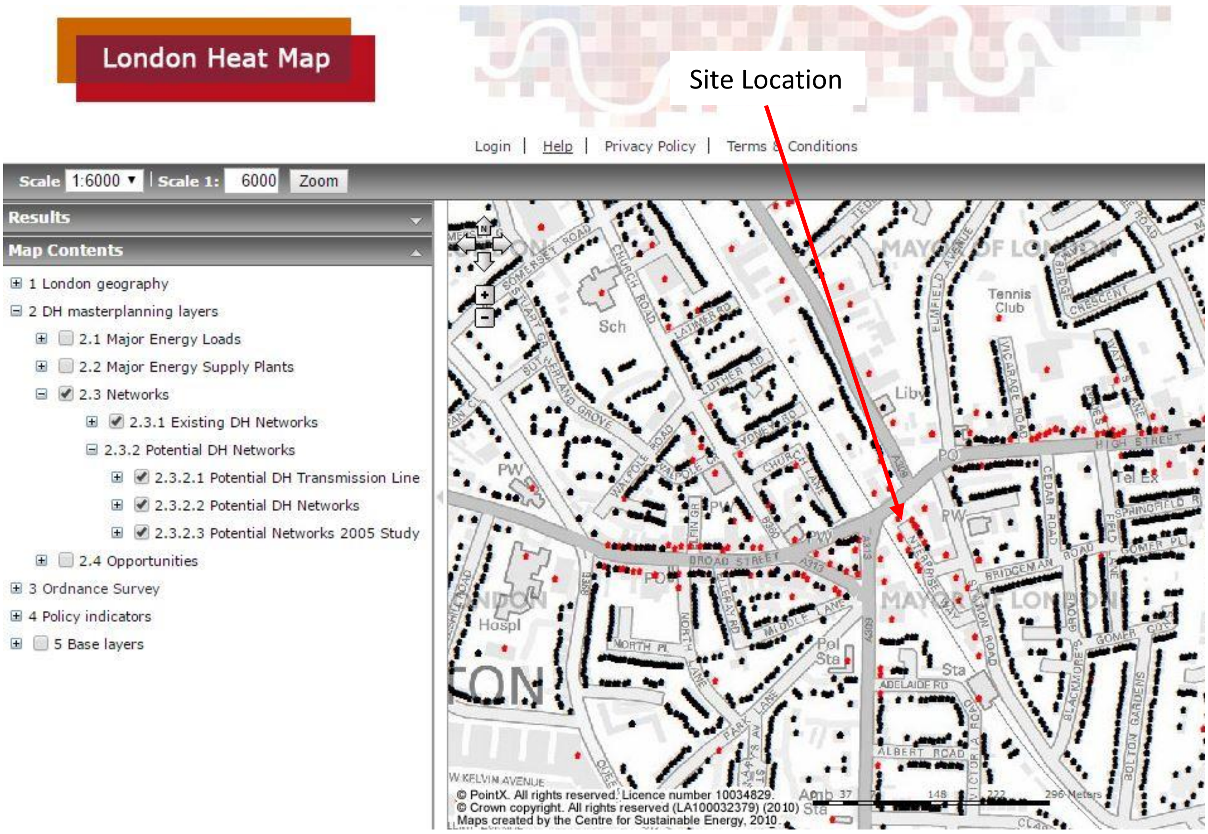


Figure 3 London Heat Map near the site

Moreover, the London heat map below identifies existing DH networks in more broaden area, and it could not find any existing DH networks (in yellow) within 1km radius from the property. The costs involved in extending the existing DH network would outweigh the advantages in this development. **Therefore, utilisation of the DH network has not been a feasible option for this development.**

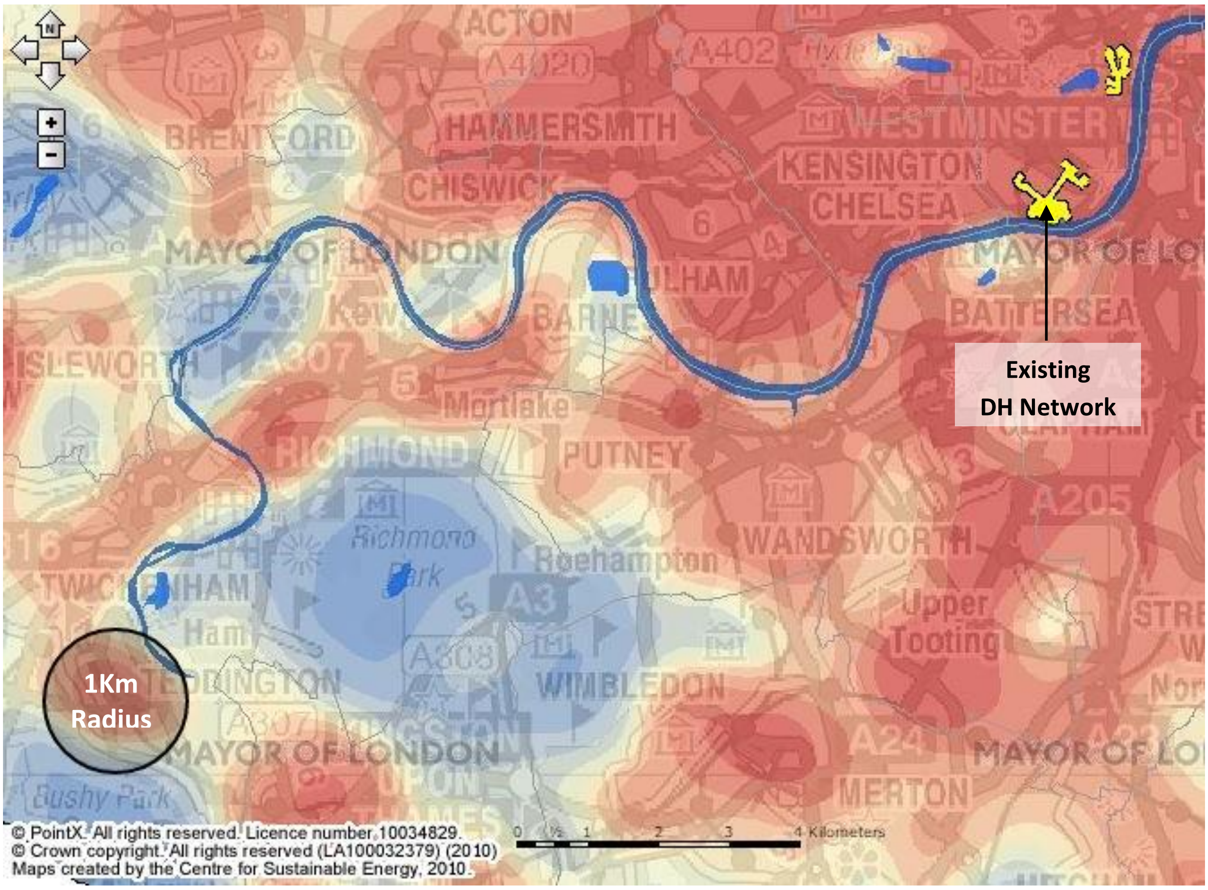


Figure 4 Existing DH Network near the site

BE CLEAN STAGE

9. BE GREEN – Renewable Energy

In this section the viable renewable energy technologies that will reduce the development's CO_2 emissions are examined. Below is a review of possible renewable technologies for incorporation in the proposed development. All of the LZC technologies are assessed against a number of criteria. Hence, LZC technology feasibility will be assessed according to the following criteria:

- ✓ Renewable energy resource or fuel availability of the LZC technology on the site.
- ✓ Space limitations due to building design and urban location of the site.
- ✓ Capital, operating and maintenance cost.
- ✓ Planning Permission
- ✓ Implementation with regards the overall M&E design strategy for building type

The renewable/LZC technologies which were found non-feasible based on the above criteria are the following:

- Solar Thermal [See Appendix Section 11.2.2]
- Wind Turbines [See Appendix Section 11.2.3]
- Small scale hydro power [See Appendix Section 11.2.4]
- Biomass Heating [See Appendix Section 11.2.4]
- Air Source Heat Pump (ASPH) [See Appendix Section 11.3.1]
- Ground Source Heat Pump (GSHP) [See Appendix Section 11.3.2]
- CHP & Micro CHP [See Appendix Section 11.3.3]
- Hydrogen Fuel Cells [See Appendix Section 11.3.4]

Available Grants information for each technology can be found in Appendix 11.4.

9.1. Photovoltaic (PV) – Proposed technology

PV panels subject to a feasibility review at detailed design stage. A PV system would provide self-generating electricity which can be sold back to the grid. The CO_2 reduction via renewables target would be achieved with the implementation of PV.

PV System specification - Whole Development

The PV system capacity for the whole development depends upon the selection of the heating system. Therefore, the amount of PV's relating to the proposed heating system option is outlined below:

- **RESIDENTIAL - Electric Room Heaters + 25.2 kWp PV**
- **COMMERCIAL - Room Heaters by ASHPs + 12.6 kWp PV**

The tables below illustrate the site and the indicative PV panel's details, and the detailed information is attached in Appendix:

Orientation	South	Number of Panels	Approxi. 120
Panel Tilt	30^o	**Power Output**	315 w/p
Overshading	Less than 20 percent	**Build Type**	New
Proportion Exported	50%	**Type**	Monocrystalline
Installation Type	Not a multi-installation	**Energy Efficiency**	EPC valid and at least Band D or higher

Table 11 Suggested PV details

It is proposed that the area on the roof could be utilised for the PV panels and condenser units. The proposed PV panels are subject to further consideration at detailed design stage. In order to qualify both the installer and the equipment must be certified under the Microgeneration Certification Scheme (MCS).

BE GREEN stage

		Regulated CO_2 Emissions		
		BE CLEAN	**BE GREEN**	**Reduction**
Residential	**kg $CO_2/m^2/yr.$**	**26.43**	**18.02**	**-**
	Tonnes CO_2/ yr.	**35.50**	**24.20**	**31.81%**
Non-Residential	**kg $CO_2/m^2/yr.$**	**32.60**	**17.40**	**-**
	Tonnes CO_2/ yr.	**9.81**	**5.24**	**46.63 %**
TOTAL	**kg $CO_2/m^2/yr.$**	**59.03**	**35.42**	**-**
	Tonnes CO_2/ yr.	**45.31**	**29.44**	**35.02%**

Table 12 Regulated Carbon Reduction at Be Green Stage

From the table above it can be seen that the overall CO_2 reduction via on-site renewables is ***35.02%*** for the total emissions.

10. Conclusion

The design of the proposed development at **2 High Street, Teddington, TW11 8EW** will be comprised of the **new construction of 23 flats and a commercial unit.** The design has incorporated building fabric enhancement (above current building regulations requirements) to increase the energy efficiency of the building. This includes that the development uses less energy, by adopting sustainable design and construction measures and by supplying energy efficiently.

The recommendation for the proposed development is **to achieve U-values and air permeability better than Building Regulations Part L1A/2A; to install high efficiency electric room heaters and hot water systems for residential units; to install high efficiency room heaters by Air Source Heat Pumps (COP 4.2) for the commercial unit; to equip Mechanical Ventilation with Heat Recovery (MVHR) for residential units; to use Accredited Construction Details for all thermal bridging junctions; to install low energy lights; and to allocate 37.8 kWp PV on the roof.** This is based on the following reasons:

1. The strategy would provide an average of **36% CO_2 reduction saving (DER/TER) against Building Regulations Part L 2013 baseline.** Therefore, the strategy meets requirements of the London Plan policies and Local policies.

2. The following hierarchy of the Mayor's Energy Strategy has been explored and implemented:
    - BE LEAN: Energy efficient design
    - BE CLEAN: Connection to district heat networks or communal heating systems
    - BE GREEN: Installation of on-site renewable energy technologies

3. At BE LEAN stage, **energy efficient measures** (high performance building fabric, efficient heating and hot water systems, Accredited Construction Details, low energy lights, and efficient ventilation systems) were suggested, and would provide about 2% carbon reduction.

4. At BE GREEN stage, **PV panels of 37.8 kWp** were proposed for the whole development, and would provide a 35% carbon reduction. The PV panels would be located on the roof areas (approximately 120 panels with 315 w/p are required).

5. **The pre-assessment for BREEAM New Construction (2014)** has been undertaken for the commercial unit demonstrating that an **"Excellent"** rating can be achieved [See the Appendix for the pre-assessment report].

After the application of the Energy Hierarchy, the regulated carbon dioxide emissions and savings are presented on the table below:

Energy Hierarchy	Strategies	Regulated Carbon Emissions (Tonnes CO_2/yr.)
BASELINE	TER set by Building Regulations 2013 Part L	46.15
BE LEAN	After energy demand reduction	45.31
BE CLEAN	After CHP/ Communal Heating	45.31
BE GREEN	After renewable energy	29.44

Table 13 Carbon Emissions after each stage of the proposed strategy

The chart below summarizes the regulated carbon dioxide savings from each stage of the proposed strategy:

Energy Hierarchy	Strategies	Regulated Carbon Savings	
		Tonnes CO_2/yr.	%
BE LEAN	After energy demand reduction	0.84	1.82 %
BE CLEAN	After CHP/ Communal Heating	-	-
BE GREEN	After renewable energy	15.87	35.02 %
Total Cumulative Savings		**16.71**	**36%**
Total Target Savings		16.15	35%

Table 14 Carbon dioxide Emissions after each stage of the Energy Hierarchy

Figure below illustrates the hierarchical approach adopted and the resultant reduction in overall CO_2 emissions.

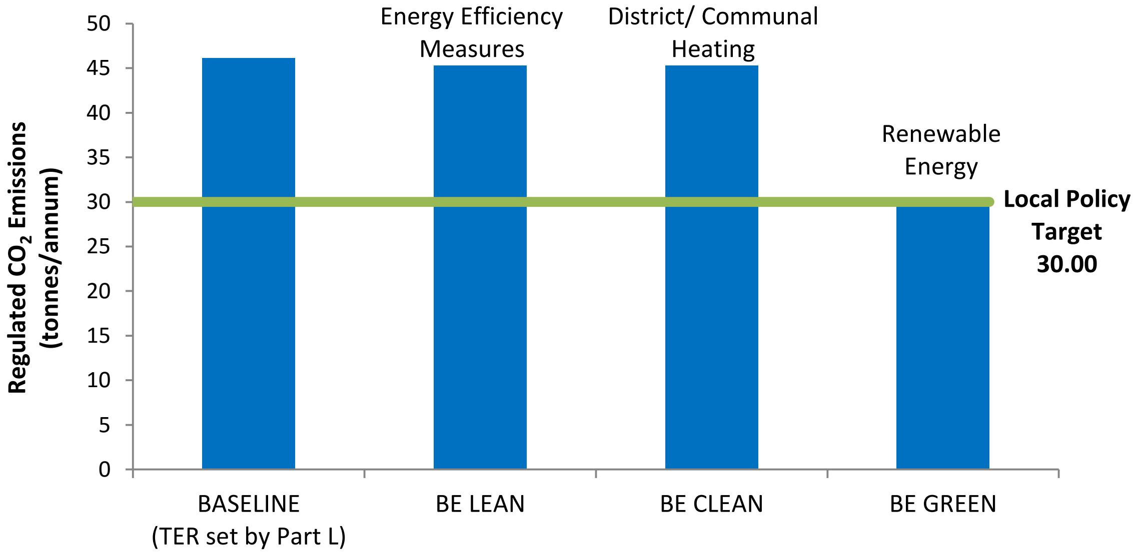


Figure 5 Carbon Emissions in Energy Hierarchy

11. Appendix

- ✓ Low & Zero Carbon Energy Systems
- ✓ SAP Block Compliance and SBEM Brukl reports
- ✓ BREEAM pre-assessment
- ✓ PV panels' detailed specifications

11.1. Low & Zero Carbon Energy Systems

The following section is an overview of the LZC energy systems that are available and can be implemented to the building environment. Firstly, a brief description of the types of renewable energy (zero carbon energy) that can be harnessed with technology will be presented. In addition, the renewable energy system technologies that harness the renewable energy and convert it to electricity, heating and hot water etc., to be consumed in buildings will be presented as well.

The second part of this section will provide an indication of the available low carbon technologies that can be installed on a building to minimise carbon emissions and reduce energy costs.

11.2. Zero Carbon Technologies

In this section the zero carbon technologies also known as Renewable Energy System Technologies (REST) are described.

- Photovoltaics (PV)
- Solar Water Heating
- Wind Turbines
- Small scale Hydro Power
- Biomass Heating

11.2.1. Photovoltaic Systems

Description of PV Systems

Photovoltaic systems convert energy from the sun directly into electricity. They are composed of photovoltaic cells, usually a thin wafer or strip of semiconductor material that generates a small current when sunlight strikes them. Multiple cells can be assembled into modules that can be wired in an array of any size. These flat-plate PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture the most sunlight over the course of a day, or even in the form of a solar PV facade. Several connected PV arrays can provide enough power for a household/building.
Thin film solar cells use layers of semiconductor materials only a few micrometers thick. Thin film technology has made it possible for solar cells to now double as rooftop

shingles, roof tiles, building facades, or the glazing for skylights or atria. The solar cell version of items such as shingles offer the same protection and durability as ordinary asphalt shingles.

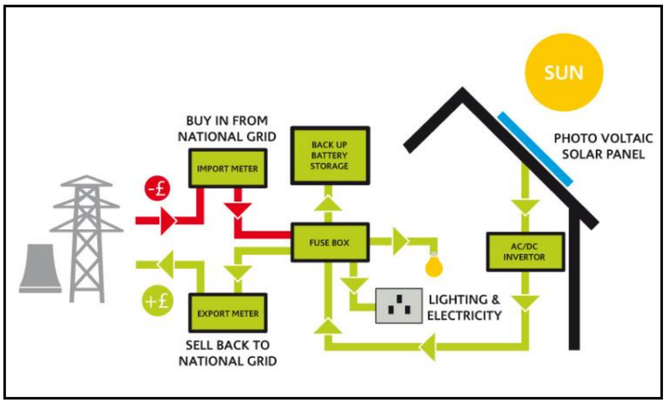
Advantages

The PV systems are relatively simple, modular, and highly reliable due to the lack of moving parts. Moreover, PV systems do not produce any greenhouse gases, on the contrary they save approximately 325kg of CO_2 per year kWp they generate.

Best Practice Design

PV installations performance is proportional to the active area (area covered by PVs). The desirable location for PV panels is on a south facing roof or façade, as long as no other building or tall trees overshadows it, resulting in reduced PV efficiency. PV panels are required strong structurally roofs due to their heavy weight, especially if the panels are placed on top of existing tiles. The area of PV panels required to generate 1 kWp varies but generally 6-8m^2 for mono-crystalline and 10m^2 for polycrystalline panels will generate 1kWp (kWp-energy generated at full sunlight) of electricity.

Cost & Maintenance



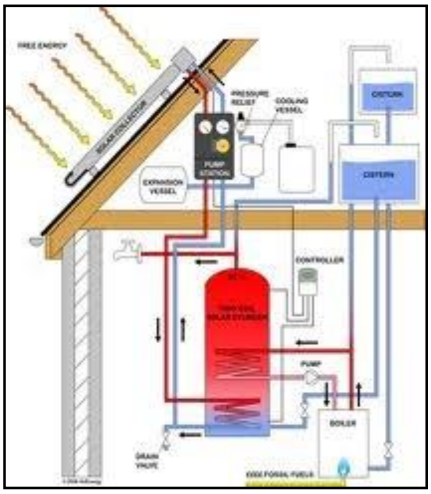
Prices for PV systems vary, depending on the size of the system to be installed, type of PV cell used and the nature of the actual building on which the PV is mounted. The size of a PV system depends on the buildings electricity demand. Solar tiles cost more than conventional panels, and panels that are integrated into a roof are more expensive than those that sit on top. Grid connected systems require very little maintenance, generally limited to ensuring that the panels are kept relatively clean and that shade from trees does not obstruct the sunlight path. However, the wiring and system components should be checked regularly by a qualified technician.

11.2.2. Solar Thermal Systems

Solar systems can be used wherever moderately hot water is required. Off-the-shelf packages provide hot water to the bathroom and kitchen of a house; custom systems are designed for bigger loads, such as multi-unit apartments.

The most common collector is called a flat-plate collector. Mounted on the roof, it consists of a thin, flat, rectangular box with a transparent cover that faces the sun. Small tubes run through the box and carry the fluid – either water or other fluid, such as an antifreeze solution – to be heated. The tubes are attached to an absorber plate, which is painted black to absorb the heat. As heat builds up in the collector, it heats the fluid passing through the tubes.

Advantages



Solar water heating can provide about a third of a typical dwellings/business hot water needs.

Planning Issues

In England, changes to permitted development rights for micro generation technologies introduced on 6th April 2008 have lifted the requirements for planning permission for most solar water heating installations. Roof mounted and stand-alone systems can now be installed in most dwellings, as long as they follow certain size criteria. Listed, English Heritage and buildings in conservation areas are exempted.

Cost & Maintenance

Evacuated tube systems are more expensive due to their higher manufacturing cost.
SWH systems in general have a 5-10 years warranty and require little maintenance. A yearly check by the owner of the system and a more detailed maintenance check by a qualified installer every 3-5 years should be adequate.

11.2.3. Wind Turbines

Description of Wind Turbine

Wind energy systems convert the kinetic energy of moving air into electricity or mechanical power. They can be used to provide power to central grids or isolated grids, or to serve as a remote power supply or for water pumping. Wind turbines are commercial units available in a vast range of sizes. The turbines used to charge batteries and pump water off-grid tend to be small, ranging from as small as 50 W up to 10 kW. For isolated grid applications, the turbines are typically larger, ranging from about 10 to 200 kW. Wind turbines are mounted on a tower to harness the most energy. At 30 meters or more aboveground, they can capture the faster and less turbulent wind in an urban environment. Turbines harness the wind's energy with their propeller-like blades. In most of the cases, two or three blades are mounted on a shaft to form a rotor.
There are two types of wind turbines that can be used for buildings:

- Mast mounted – which are free standing and located near the building that will be consuming the generated electricity.
- Roof Mounted – which can be installed on house roofs and other buildings.

Planning Issues

Planning issues such as visual impact, noise and conservation issues also have to be considered. System installation normally requires permission from the local authority.

Cost & Maintenance

- Roof mounted turbines cost from £3000. The amount of energy and carbon that roof top micro wind turbines save depends on size, location, wind speed, nearby buildings and the local landscape. At the moment there is not enough data from existing wind turbine installations to provide a figure of how much energy and CO_2 could typically be saved. The Energy saving trust is monitoring up to 100 installations nationwide which will give ball park figures of carbon savings.
- Mast Mounted turbines in the region of 2.5kW to 6kW would cost approximately £11000-£19000. These costs are inclusive of the turbine, mast, inverters, battery storage and installation cost. It should be noted that these costs vary depending on location, size and type of system to be installed.
- Turbines have an operational lifetime of up to 22.5 years but require service checks every few years to ensure efficient operation. For battery storage systems, typical battery life is around 6-10 years, depending on the type, so batteries may have to be replaced at some point in the system's life.

Feasibility on the site

Wind turbines are not feasible for the development due to the insufficient wind speed. Since the development is located in a dense residential and commercial units area; the wind resource may be restricted due to the adjacent large trees and air turbulence generated between them. As shown below (http://tools.decc.gov.uk/en/windspeed/default.aspx), the yearly average wind speed at this site is quite low at 10 meters above ground.

FOR THE 1KM GRID SQUARE 516 101 (TQ1601)

Wind speed at 45m agl (in m/s)

6.6	6.7	

Wind speed at 25m agl (in m/s)

6.2	6.3	

Wind speed at 10m agl (in m/s)

5.7	5.8	

Blank squares indicate areas outside the land area of the UK - i.e. areas at sea or of neighbouring countries.
agl = above ground level.
Squares surrounding the central square correspond to wind speeds for surrounding grid squares.

An actual wind-speed measurement using an anemometer has not been used for the purpose of this energy strategy report.

Wind turbine(s) have been discounted for this development scheme for the following reasons:

- A large mast horizontal axis wind turbine will not be able to generate electricity at optimal operating range since it requires higher average wind speeds. Furthermore, the installation of small scale wind turbines won’t be feasible due to low average wind speed at 10 meters height, 25m & 45metre heights.
- Due to the close proximity of neighbouring Commercial units & residential properties and trees.
- In addition, the low frequency noise generated by wind turbines might cause inconvenience to the neighbouring residents. However, the level a person can be affected by low frequency noise varies from individual to individual.
- Due to the size and the required height of a potential wind turbine scheme there is also an issue with the propellers’ impacting bird traffic, obtrusiveness, shadow flicker which means that generally large wind turbines need to be located at least 300m from any residential properties, which would not be possible on this site.
- Roof mounted units are limited in size due to wind induced stresses which are transmitted to the building structure. Most roof mounted turbines currently on the market are

approximately 2m diameter and capable of producing 1-1.5kW each. However, the output is dependent on the surrounding obstructions and local wind speed. Thus small scale wind turbines would not make any meaningful impact on a site such as this.

- There are likely to be planning issues associated with wind turbines of a size necessary to affect any significant CO2 savings or energy savings.
- Because of the above the investment case with regards this technology solution is not viable compared to other solutions with a more attractive ROI.
- Finally, the installation of wind turbines on the development requires planning permission (and is likely to instigate neighbourhood committee interest regarding its aesthetics and acoustic issues).

11.2.4. Small Scale Hydro

Description of Small Scale Hydro System

Small hydro systems convert the potential and kinetic energy of moving water into electricity, by using a turbine that drives a generator. As water moves from a higher to lower elevation, such as in rivers and waterfalls, it carries energy with it; this energy can be harnessed by small hydro systems. Used for over one hundred years, small hydro systems are a reliable and well-understood technology that can be used to provide power to a central grid, an isolated grid or an off-grid load, and may be either run-of-river systems or include a water storage reservoir.

In a residential small scale hydro system the constant flow of water is critical to the success of the project. The energy available from a hydro turbine is proportional to the flow rate of the water and the head height. Since the majority of the cost of a small hydro project stems from up front expenses in construction and equipment purchase, a hydro project can generate large quantities of electricity with very low operating costs and modest maintenance expenditures for 50 years or longer.

Advantages

For houses with no mains connection but with access to a micro hydro site, a good hydro system can generate a steady, more reliable electricity supply than other renewable technologies at lower cost. Total system costs can be high but often less than the cost of a grid connection and with no electricity bills to follow.

Cost & Maintenance

Small hydro schemes are very site specific and are related to energy output. For low heat systems, costs may lie in the region of £4,000 per kW installed up to about 10kW and would drop per kW for larger schemes.

For medium heads, there is a fixed cost of about £10,000 and about £2,500 per kW up to around 10kW Unit costs drop for larger schemes. Maintenance costs vary but small scale hydro systems are very reliable.

Feasibility on the site

Small scale hydro-electric will not be studied any further because of the location and the spatial limitations of the development. There is no river or lake within the development site boundaries. As a result, this solution will not be assessed any further.

11.2.5. Biomass Heating

Description of Biomass Heating System

Biomass heating systems also known as biomass boilers burn organic matter—such as wood chips, agricultural residues or municipal waste—to generate heat for buildings. They are highly efficient heating systems, achieving near complete combustion of the biomass fuel through control of the fuel and air supply, and often incorporating automatic fuel handling transport systems. Biomass boilers consist of a boiler, a heat distribution system, and a fuel transportation system. The biomass heating system typically makes use of multiple heat sources, including a waste heat recovery system, a biomass combustion system, a peak load boiler, and a back-up boiler. The heat distribution system conveys hot water or steam from the heating plant to the loads that may be located within the same building as the heating plant, as in a system for a single institutional or industrial building, or, in the case of a "district heating" system, clusters of buildings located in the vicinity of the heating plant.

Biomass heating systems have higher capital costs than conventional boilers and need diligent operators. Balancing this, they can supply large quantities of heat on demand with very low fuel costs, depending on the origin of the fuel.

Best Design Practice

It's important to have storage space for the fuel and appropriate access to the boiler for loading the fuel. A local fuel supplier should be present in order to make the scheme viable.
The vent material must be specifically designed for wood appliances and there must be sufficient air movement for proper operation of the stove. Chimneys can be fitted with a lined flue.
A Biomass heating system installation should comply with all safety and building regulations. Wood can only be burned in exempted appliances, under the Clean Air Act.

Advantages

Producing energy from Biomass has both environmental and economic advantages. Although Biomass produces CO_2 it only releases the same amount that is absorbed whilst growing, which is why it is considered to be carbon neutral. Furthermore, Biomass can contribute to waste management by harnessing energy from products that are often disposed at landfill sites.
It is most cost effective and sustainable when a local fuel source is used, which results in local investment and employment, which in addition minimizes transport emissions.

Planning Issues

If the building is listed or is in an area of outstanding natural beauty, then it is required that the Local Authority Planning department is notified before a flue is fitted.

Cost & Maintenance

Stand-alone room heaters cost £2,000 to £4,000. Savings will depend on how much they are used and which fuel you are replacing. A Biomass stove which provides a detached home with 10% of annual space heating requirements could save around 840kg of CO_2 when installed in an electrically heated home. Due to the higher cost of Biomass pellets compared with other heating fuels, and the relatively low efficiency of the stove compared to a central heating system it will cost more to run.
The cost of Biomass boilers varies depending on the system choice; a typical 15kW pellet boiler would cost about £5,000-£14,000 installed, including the cost of the flue and commissioning process. A

manual log feed system of the same size would be slightly cheaper. A wood pellet boiler could save around £750 a year in energy bills and around 6 tons of CO_2 per year when installed in an electrically heated home. In terms of biomass fuel costs, they generally depend on the distance between the dwelling and the supplier and whether large quantities can be bought.

Feasibility on the site

Biomass boilers should not be considered for this project due to the following reasons:

- Furthermore, in common with other types of combustion appliances, biomass boilers are potentially a source of air pollution. Pollutants associated with biomass combustion include particulate matter (PM_{10}/ $PM_{2.5}$) and nitrogen oxides (NO_X) EMISSIONS. These pollution emissions can have an impact on local air quality and affect human health. Biomass has recently been rejected by many London Boroughs as means of obtaining the on-site renewable contribution (and this will soon send ripples out to other regions). This is because of their associated flue emissions (which can be significantly higher than gas fired boilers) and the difficulty of ensuring the boiler will operate at its optimum efficiency, which is often quoted by designers at the initial design stages. Biomass flue emissions are often difficult to control because the quality of fuel can vary significantly between suppliers. Given this a bio fuel system may not be acceptable to the Council on planning grounds (e.g. concerns about associated flue emissions/impact on local 'Air Quality', increase in road traffic from pellet delivery lorries).
- Biomass fuel requires more onerous and frequent wood fuel silo (site storage issues) replenishing by delivery trucks- which in turn can cause site transportation issues that will need to be considered and addressed along with the impact on the other residents and neighborhood infrastructure.
- Restrictions on the type of fuel and appliance may apply to the development and according to studies commissioned by DEFRA the levels of particles emitted by the burning of wood chip or waste would be considered to outweigh the benefits of carbon reduction especially in an urban environment such as the proposed development site.
- Dependent on a fuel supply chain contract being confirmed.
- There is no suitable location for the plant and storage of the pellets on site at present.

11.3. **Low Carbon Technologies**

In this section the low carbon technologies are described.

- Air Source Heat Pumps (ASHP)
- Ground Source Heat Pumps (GSHP)
- Combined Heat and Power (CHP) & Micro CHP
- Fuel Cells

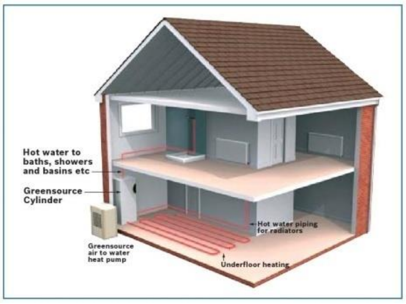
11.3.1. Air Source Heat Pumps (ASHP)

Description of Air Source Heat Pumps

Air source heat pumps work in a very similar way to fridges and air conditioners and absorb heat from the air. They are ideally suited to work with under floor heating systems because of the lower design temperatures of under floor systems. The lower the water temperature, the higher the COP. Air source heat pumps use air. They are fitted outside a house; generally perform better at slightly warmer air temperatures. The seasonal efficiencies of air source heat pumps are between 200% - 400%. Heat pumps can operate at outside temperatures down to –15 degC, although there is a drop in COP.

Advantages

- A reduction in carbon emission.
- No boiler flues and danger of carbon monoxide leakage.
- Maintenance is carried outside the premises.
- No annual boiler servicing and safety checks.
- Heat pump life expectancy about 25 years compared to a boiler of 15 years



Costs & Savings

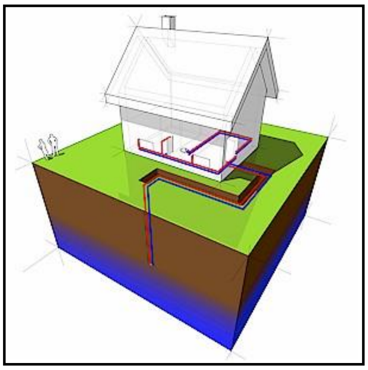
Operating Cost Savings around 15% in comparison with a typical gas fired condensing boiler installation with HWS cylinder and an electrically driven Community air to water heat pump.

11.3.2. Ground Source Heat Pumps (GSHP)

Description of Ground Source Heat Pumps

Ground-source heat pumps provide low temperature heat by extracting it from the ground or a body of water and provide cooling by reversing this process. Their principal application is space heating and cooling, though many also supply hot water. They can even be used to maintain the integrity of building foundations in permafrost conditions, by keeping them frozen through the summer.

A ground-source heat pump (GSHP) system has three major components: the earth connection, a heat pump, and the heating or cooling distribution system. The earth connection is where heat transfer occurs. One common type of earth connection comprises tubing buried in horizontal trenches or vertical boreholes, or alternatively, submerged in a lake or pond. An antifreeze mixture, water or another heat-transfer fluid is circulated from the heat pump, through the tubing, and back to the heat pump in a “closed loop.” “Open loop” earth connections draw water from a well or a body of water, transfer heat to or from the water, and then return it to the ground or the body of water.



Since the energy extracted from the ground exceeds the energy used to run the heat pump, GSHP “efficiencies” can exceed 100%, and routinely average 200 to 500% over a season. Due to the stable, moderate temperature of the ground, GSHP systems are more efficient than air-source heat pumps, which exchange heat with the outside air. GSHP systems are also more efficient than conventional heating and Air-conditioning technologies, and typically have lower maintenance costs. They require less space, especially when a liquid building loop replaces voluminous air ducts, and, since the tubing is located underground, are not prone to vandalism like conventional rooftop units. Peak electricity consumption during cooling season is lower than with conventional air-conditioning, so utility demand charges may be reduced. Heat pumps typically range in cooling capacity from 3.5 to 35 kW (1 to 20 tons of Cooling). A single unit in this range is sufficient for a house or small Commercial units Building. The heat pump usually generates hot or cold air to be distributed locally by conventional ducts.

Advantages

The efficiency of GSHP system is measured by the coefficient of performance (COP). This is the ratio of units of heat output for each unit of electricity used to drive the compressor and pump for the ground loop. Average COP known as seasonal efficiency, is around 3-4 although some systems may produce a greater rate of efficiency. This means that for every unit of electricity used to pump the heat, 3-4 units of heat are produced, making it an efficient way of heating a building. If grid electricity is used for the compressor and pump, then a range of energy suppliers should be consulted in order to benefit from the lower running costs.

Cost & Savings

A typical 8-12kW system costs £6,000-£12,000 (not including the price of distribution system). This can vary with property and location. When installed in an electrically heated home a GSHP could save as much as £900 a year on heating bills and almost 7 tonnes of CO_2 a year. Savings will vary depending on what fuel is being replaced.

Feasibility on the site

GSHP will not be studied any further for the following reasons:

- If an open loop configuration was to be adopted, a test borehole would be needed to assess the available resource. The test resource process is expensive and of course does not guarantee an acceptable resource in the ground. Additionally, a closed loop borehole configuration could not be used due to spatial limitations of the site.
- There are likely to be planning issues associated with borehole excavation and drilling.
- Running costs and maintenance may be minimal. However, installation is a costly affair. A GSHP solution would represent a relatively expensive option in comparison to other renewable technologies available.

- Additional electric immersion and pumps would be required to heat the GSHP water up to suitable temperature to be used around the building and it's likely a centralised plant area will also be required to house the circulation pumps.
- This technology is not recommended due to the increased plant energy consumption requirements in turn impacting the DER/TER score for the required energy strategy objectives.
- Furthermore, boreholes also destabilize the ground surface and may be considered a minus for environmentally friendly endeavours.

11.3.3. Combined Heat and Power (CHP) & Micro CHP

Description of CHP

The principle behind combined heat and power (cogeneration) is to recover the waste heat generated by the combustion of a fuel6 in an electricity generation system. This heat is often rejected to the environment, thereby wasting a significant portion of the energy available in the fuel that can otherwise be used for space heating and cooling, water heating, and industrial process heat and cooling loads in the vicinity of the plant. This cogeneration of electricity and heat greatly increases the overall efficiency of the system, anywhere from 25-55% to 60-90% depending on the equipment used, and the application.

A CHP installation comprises four subsystems: the power plant, the heat recovery and distribution system, an optional system for satisfying heating and/or cooling loads and a control system. A wide range of equipment can be used in the power plant, with the sole restriction being that the power equipment rejects heat at a temperature high enough to be useful for the thermal loads at hand. In a CHP system, heat may be recovered and distributed as hot water, conveyed from the plant to low temperature thermal loads in pipes for hot water, or for space heating.

Advantages

CHP can significantly reduce primary energy consumption, and can therefore have a major impact on CO2 emissions associated with the combustion of fossil fuels in conventional boilers. Each 1 kW of electrical capacity provided by CHP plant using fossil fuels has the potential to reduce annual CO2 emissions by around 0.6 tonnes compared to gas-fired boilers and fully grid-derived electricity. For plant which is fuelled by renewable energy sources the potential is much greater.

Costs & Savings

Capital costs for CHP installations are higher than for alternative systems, but this can be recovered over a relatively short period of time (typically 5–10 years) for installations where there is a demand for heat and power for 4500 hours or more each year. The cost effectiveness is very sensitive to the relative price of electricity and fossil fuel which have been subject to frequent variations since de-regulation of the energy supply industries.

Micro CHP

Micro CHP (Combined Heat & Power) is the simultaneous production of useful heat and power within the home. It works very much like the gas boiler in a central heating system and heats the home in just the same way. However, at the same time it generates electricity, some of which will be used in the dwelling and the remainder will be exported to the electricity grid. Effectively the micro CHP unit replaces the gas central heating boiler and provides heat and hot water as usual, but additionally provides the majority of the home's electricity needs. Although individual units produce, by definition, relatively small amounts of electricity, the significance of micro CHP lies in the potentially huge numbers of systems which may ultimately be installed in the millions of homes in the UK where natural gas is currently the dominant heating fuel.

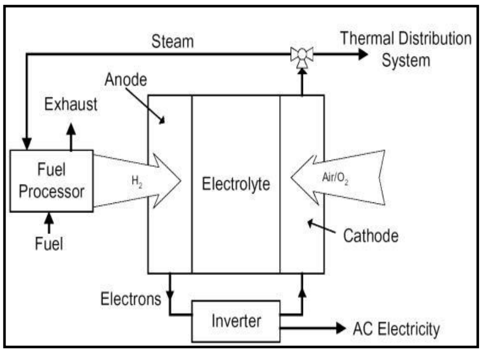
Feasibility on the site

CHP has not been considered further for this project for the following reasons:

- The average maximum heating load of a new apartment (built to 2010 building regs) is approximately 3kW and therefore most individual heating systems with independent condensing gas boilers would be incapable of working at optimal efficiencies or achieving their stated SEDBUK rating due to boiler cycling.
- Traditional CHP should not be considered for this project due to the spatial constraints of the development plot and dwelling layouts. There is not suitable space in the development for CHP plant.
- Heat from the CHP plant could be utilized to drive an absorption chiller during the summer months (tri-generation), but due to the sustainable design of the building fabric, and the use of natural ventilation wherever possible, we anticipate that the cooling load will be minimal, making this a non-viable proposition.
- Micro-CHP is a relatively new concept and issues are raised in relation to unproven technology, inefficiency for shorter run cycles and lack of technical knowledge that can limit the practical application of micro CHP at present. In addition, high installation costs and estimated low life expectancy has also been taken into consideration as to its commercial unit's un-viability for this development scheme. Micro-CHP also has a lower FIT tariff rate and period duration and is only applicable for systems under 2kW.

11.3.4. Fuel Cells

Description of Fuel Cells



A fuel cell is a device that generates more electricity by a chemical reaction. Every fuel cell has two electrodes, one positive and one negative, called, respectively, the anode and cathode. The reactions that produce electricity take place at the electrodes.

Every fuel cell also has an electrolyte, which carries electrically charged particles from one electrode to the other, and a catalyst, which speeds the reactions at the electrodes. Hydrogen is the basic fuel, but fuel cells also require oxygen.

One great appeal of fuel cells is that they generate electricity with very little pollution—much of the hydrogen and oxygen used in generating electricity ultimately combine to form a harmless by product, namely water.

Fuel Cell Operation

The purpose of a fuel cell is to produce an electrical current that can be directed outside the cell to do work, such as powering an electric motor or illuminating a light bulb or a city. Because of the way electricity behaves, this current returns to the fuel cell, completing an electrical circuit. The chemical reactions that produce this current are the key to how a fuel cell works.

There are several kinds of fuel cells, and each operates a bit differently. But in general terms, hydrogen atoms enter a fuel cell at the anode where a chemical reaction strips them of their electrons. The hydrogen atoms are now "ionized," and carry a positive electrical charge. The negatively charged electrons provide the current through wires to do work. If alternating current (AC) is needed, the DC output of the fuel cell must be routed through a conversion device called an inverter.

Advantages

Even better, since fuel cells create electricity chemically, rather than by combustion, they are not subject to the thermodynamic laws that limit a conventional power plant. Therefore, fuel cells are more efficient in extracting energy from a fuel. Waste heat from some cells can also be harnessed, boosting system efficiency still further.

Fuel Cells with Hydrogen from Renewable Sources

Fuel cells can be used as CHP systems in buildings. There are currently several different systems under development using different chemical processes, which operate at different temperatures. They currently use natural gas as the fuel, which is reformed to produce hydrogen, the required fuel for the fuel cell. When and if hydrogen becomes available from renewable energy, fuel cell CHP from renewable sources may be possible in buildings.

11.4. **Available Grants**

11.4.1. Renewable Heat Incentive (RHI)

- ✓ **Domestic RHI tariff rates**

Table below specifies the current and future tariffs for each available renewable technology on the 31st of March 2016 (https://www.ofgem.gov.uk/environmental-programmes/domestic-renewable-heat-incentive-domestic-rhi/about-domestic-rhi/tariffs-and-payments-domestic-rhi). As the tariff keeps changing, it has to be checked at appropriate design stage.

Applications submitted	Biomass boilers and stoves	Air source heat pumps	Ground source heat pumps	Solar thermal
01/01/16 - 31/03/16	5.14p	7.42p	19.10p	19.51p
01/04/16 - 30/06/16*	5.20p	7.51p	19.33p	19.74p
01/07/2016 - 30/09/2016**	If any new tariff changes are to be made due to degression, the next announcement by DECC would be by 1 June 2016.			

✓ **Non-Domestic RHI tariff rates**

The table below specifies tariffs that apply for installations with an accreditation date on or after 1 April 2016 (https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi/tariffs-apply-non-domestic-rhi-great-britain).

Tariff name	Eligible technology	Eligible sizes	Tariffs
Small commercial biomass	Solid biomass including solid biomass contained in waste	Less than 200 kWth	3.62
		Tier 1	
		Less than 200 kWth	
		Tier 2	0.96
Medium commercial biomass		200 kWth and above & less than 1MWth Tier 1	5.24
		200 kWth and above & less than 1MWth Tier 2	2.27
Large commercial biomass		1MWth and above	2.05
Solid biomass CHP systems (commissioned on or after 4 December 2013)	Solid biomass CHP systems	all capacities	4.22
Water/Ground-source heat pumps	Ground-source heat pumps & Water-source heat pumps	all capacities Tier 1	8.95
		Tier 2	2.67
Air-source heat pumps (commissioned on or after 4 December 2013)	Air-source heat pumps	all capacities	2.57
Deep geothermal (commissioned on or after 4 December 2013)	Deep geothermal	all capacities	5.14
All solar collectors	Solar collectors	Less than 200 kWth	10.28

Biomethane injection	Biomethane	On the first 40,000 MWh of eligible biomethane Tier 1	5.35
		Next 40,000 MWh of eligible biomethane Tier 2	3.14
		Remaining MWh of eligible biomethane Tier 3	2.42
Small biogas combustion	Biogas combustion	Less than 200 kWth	6.94
Medium biogas combustion (commissioned on or after 4 December 2013)		200 kWth and above & less than 600 kWth	5.45
Large biogas combustion (commissioned on or after 4 December 2013)		600 kWth and above	2.04

11.4.2. Feed In Tariff (FIT)

The table below shows the listing of all generation tariff levels for installations before 1st April 2016, which is current data on the official webpage (http://www.fitariffs.co.uk/eligible/levels/). Tariffs after 1st April 2016 as per the degression table, but adjusted for RPI indexation and contingent degression. Therefore, the detailed tariff has to be checked at appropriate design stage.

Energy Source	Scale	Type / Rate	Tariff (p/kWh)	
		Non-PV	< 15/01/16	> 8/2/16
Anaerobic digestion	≤250kW		9.12	tba [1]
Anaerobic digestion	>250kW - 500kW		8.42	tba [1]
Anaerobic digestion	>500kW		8.68	tba [1]
Hydro	≤15 kW		15.45	8.54
Hydro	>15 - 100kW		14.43	8.54
Hydro	>100kW - 500kW		11.40	6.14
Hydro	>500kW - 2MW		8.91	6.14
Hydro	>2MW - 5MW		2.43	4.43
Micro-CHP	<2 kW	(limited)	13.45	tba [1]
Solar PV	≤4 kW	Higher rate	12.88	4.39
Solar PV	≤4 kW	Medium rate	11.67	
Solar PV	>4 - 10kW	Higher rate	11.71	4.39
Solar PV	>4 - 10kW	Medium rate	10.54	
Solar PV	>10 - 50kW	Higher rate	11.71	4.59
Solar PV	>10 - 50kW	Medium rate	10.54	
Solar PV	>50 - 150kW	Higher rate	9.63	2.70
Solar PV	>50 - 150kW	Medium rate	8.67	
Solar PV	>150 - 250kW	Higher rate	9.21	2.70
Solar PV	>150 - 250kW	Medium rate	8.29	
Solar PV	≤250kW	Lower rate	6.16	
Solar PV	>250kW - 5MW		5.94	2.27
Solar PV	>1MW - 5MW		5.94	0.87
Solar PV	≤5MW	Standalone	4.44	0.87
Wind	≤100kW		13.73	8.53
Wind	>100 - 500kW		10.85	8.53
Wind	>500kW - 1.5MW		5.89	5.46
Wind	>1.5MW - 5MW		2.49	0.86
Any	existing systems transferred from RO		10.66	10.66

Block Compliance WorkSheet: Informer House

User Details

Assessor Name:

Stroma Number:

Software Name: Stroma FSAP

Software Version: Version: 1.0.3.4

Calculation Details

Dwelling	DER	TER	DFEE	TFEE	TFA
Flat 1- Type 1A facing S	16.84	26.21	28.3	38.5	51
Flat 2 - Type 1A facing N	19.38	28.45	36.1	46.2	51
Flat 3 - Type 1B	17.4	28.28	31.1	44.7	50
Flat 4 - Type 2A	18.41	25.87	33.2	44.6	65
Flat 5- Type 2WAU	15.72	22.81	27.4	38.2	77
Flat 6 - Type 1A Facing S	15.96	26.21	28.3	38.5	51
Flat 7 - Type 1A facing N	19.38	28.45	36.1	46.2	51
Flat 8 - Type 1B	17.4	28.28	31.1	44.7	50
Flat 9 - Type 2A	18.41	25.87	33.2	44.6	65
Flat 10 - Type 2WAU	15.72	22.81	27.4	38.2	77
Flat 11 - Type 1A Facing S	15.96	26.21	28.3	38.5	51
Flat 12 - Type 1B	17.4	28.28	31.1	44.7	50
Flat 13 - Type 2A	18.41	25.87	33.2	44.6	65
Flat 14 - Type 2B	18.34	26.12	33	44.1	62
Flat 15 - Type 2C	16.33	24.37	28.3	39	64
Flat 16 - Type 1A facing S	15.96	26.21	28.3	38.5	51
Flat 17 - Type 1B	17.4	28.28	31.1	44.7	50
Flat 18 - Type 2A	18.41	25.87	33.2	44.6	65
Flat 19 - Type 2B on the top	21.44	28.99	39.3	53.8	62
Flat 20 - Type 2C on the top	26.87	27.22	34.3	48.6	64
Flat 21 - Type 1A facing S on the top	18.7	29.46	34.3	49.5	51
Flat 22 - Type 2A on the top	21.58	29.12	39.6	55.5	65
Flat 23 - Type 1B on the top	20.83	31	37.8	56.7	55

Block Compliance WorkSheet: Informer HouseCont...

Calculation Summary

Total Floor Area	1343.00
Average TER	26.78
Average DER	18.39
Average DFEE	32.33
Average TFEE	44.61
Compliance % Improvement DER|TER % Improvement DFEE|TFEE	Pass 31.33 27.53

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

Informer house

As designed

Date: Fri May 06 12:01:54 2016

Administrative information

Building Details

Address: 2 Hight Street, Teddington, Teddington, TW11 8EW

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.2.g.3

Interface to calculation engine: Virtual Environment

Interface to calculation engine version: v7.0.5

BRUKL compliance check version: v5.2.g.3

Owner Details

Name: Downpace Limited

Telephone number:

Address: Duane Morris 2nd floor, 10 Chiswell Street, Londong, EC1Y 4UW

Certifier details

Name: Syntegra

Telephone number: 0845009162

Address: 63 Milford Road, Reading, RG1 8LG

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

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	33.8
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	33.8
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	17.4
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

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

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

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.12	0.12	CM000000_W1_-1
Floor	0.25	0.12	0.12	CM000000_F_1
Roof	0.25	-	-	"No heat loss roofs"
Windows***, roof windows, and rooflights	2.2	1.2	1.2	CM000000_W1-W0
Personnel doors	2.2	-	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

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

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

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3.5

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	<0.9

1- ASHP

	Heating efficiency	**Cooling efficiency**	**Radiant efficiency**	**SFP [W/(l/s)]**	**HR efficiency**
This system	4.2	-	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					NO
* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.					

1- SYST0001-DHW

	Water heating efficiency	**Storage loss factor [kWh/litre per day]**
This building	1	-
Standard value	1	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	**System type in Non-domestic Building Services Compliance Guide**
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	**SFP [W/(l/s)]**									**HR efficiency**	
ID of system type	**A**	**B**	**C**	**D**	**E**	**F**	**G**	**H**	**I**		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	**Zone**	**Standard**
Commercial 1	-	-	-	-	-	-	-	-	-	-	N/A
Commercial 2	-	-	-	-	-	-	-	-	-	-	N/A
Commercial 3	-	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	**Luminous efficacy [lm/W]**			
Zone name	**Luminaire**	**Lamp**	**Display lamp**	**General lighting [W]**
Standard value	60	60	22	
Commercial 1	-	80	35	1701
Commercial 2	-	80	35	924
Commercial 3	-	80	35	1979

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	**Solar gain limit exceeded? (%)**	**Internal blinds used?**
Commercial 1	YES (+2.8%)	NO

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Commercial 2	YES (+4.7%)	NO
Commercial 3	NO (-12.3%)	NO

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	YES
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	YES

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m^2]	314.6	314.6
External area [m^2]	533.6	533.6
Weather	LON	LON
Infiltration [m^3/hm^2@ 50Pa]	4	3
Average conductance [W/K]	199.47	275.51
Average U-value [W/m^{2}K]	0.37	0.52
Alpha value* [%]	25.27	15.09

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

Building Use

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

Energy Consumption by End Use [kWh/m^2]

	Actual	Notional
Heating	3.86	7.16
Cooling	0	0
Auxiliary	0	0
Lighting	57.21	58.39
Hot water	1.7	1.96
Equipment*	20.26	20.26
TOTAL**	**62.76**	**67.51**

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

Energy Production by Technology [kWh/m^2]

	Actual	Notional
Photovoltaic systems	29.32	0
Wind turbines	0	0
CHP generators	0	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m^2]	379.16	341.12
Primary energy* [kWh/m^2]	192.69	198.38
Total emissions [kg/m^2]	17.4	33.8

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

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] Other local room heater - fanned, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	46.7	332.4	3.9	0	0	3.36	0	4.2	0
	Notional	62.7	278.4	7.2	0	0	2.43	0	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	**$U_{i\text{-}Typ}$**	**$U_{i\text{-}Min}$**	**Surface where the minimum value occurs***
Wall	0.23	0.12	CM000000_W1_-1
Floor	0.2	0.12	CM000000_F_1
Roof	0.15	-	"No heat loss roofs"
Windows, roof windows, and rooflights	1.5	1.2	CM000000_W1-W0
Personnel doors	1.5	-	"No external personnel doors"
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	**Typical value**	**This building**
m³/(h.m²) at 50 Pa	5	3.5

BREEAM UK New Construction 2014 Pre-Assessment Estimator

General information

BRE Assessment reference no.	BREEAM
Client name	RHP
Building end user/occupier	Richmond Housing Partnership
Assessor name	Umer Uzair
Assessor organisation	Syntegra Consulting Limited

Building details

Building name	Informer House, Teddington
Country	England
Building type (main description)	Office
Building type (sub-group)	Office - General office building
Building floor area (GIA) m^2	306
Building floor area (NIFA) m^2	280
BREEAM scheme	New Construction
BREEAM version	2014 (SD5076)
BREEAM UK 2014 technical manual issue number	SD5076 Issue 4.0
Project type	New Construction (Fully fitted)
Assessment stage	Pre-Assessment
Location type	London Borough
If applicable, does this industrial building have a heated or cooled operational area?	Option not applicable to building type
Does water heating contribute less than 10% of the buildings total energy consumption?	No
Commercial/industrial refrigeration and storage systems	No
Building user transportation systems (lifts and/or escalators)	No
Laboratory function/area and size category	No laboratory
Laboratory containment level	No laboratory
Fume cupboard(s) and/or other containment devices	No
Unregulated water uses present? (e.g. vehicle wash system, irrigation)	No
If applicable, will this healthcare building house inpatients?	Option not applicable to building type
If applicable, does this industrial building have an office area?	Option not applicable to building type
If applicable, does this building contain areas requiring SAP assessment?	Option not applicable to building type
If SAP used, what proportion of the building's total floor area (GIA) does it apply to?	Option not applicable to building type

BREEAM®

BREEAM UK New Construction 2014 Pre-Assessment Estimator: Assessment Issue Scoring

BREEAM® UK

Building name	Informer House, Teddington
Building score (%)	70.30%
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
Will stakeholder consultation (project delivery) take place?	Yes	1	1
Will stakeholder consultation (third party) take place?	Yes	1	1
Will a sustainability champion (design) be assigned?	No	1	0
Will a sustainability champion (monitoring progress) be assigned?	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

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

Assessment Criteria	Compliant?	Credits available	Credits achieved
Will an elemental life cycle cost (LCC)analyses be carried out?	No	2	0
Will a component level LCC plan be developed?	No	1	0
Will the predicted capital cost be reported?	No	1	0
Expected capital cost of the project (if available)		£/m^2	

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

Comments/notes:

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		
Will/does the principal contractor operate a compliant Environmental Management System?	Yes	1	1
Will a construction stage sustainability champion be assigned?	Yes	1	1
Will a considerate construction scheme be used by the principal contractor? (One credit where 'compliance' has been achieved. Two credits where 'compliance' is significantly exceeded.)	2	2	2
Will construction site impacts be metered/monitored?	Yes		
Will site utility consumption be metered/monitored?	Yes	1	1
Will transport of construction materials and waste be metered/monitored?	Yes	1	1
Will exemplary level criteria be met?	No	1	0

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	6
Total contribution to overall building score	3.43%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Outstanding level

Comments/notes:

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
Will commissioning schedule and responsibilities be developed & accounted for?	Yes	1	1
Will a commissioning manager be appointed?	Yes	1	1
Will the building fabric be commissioned?	No	1	0
Will a building user guide be developed prior to handover?	Yes	1	1
Will a training schedule be prepared for building occupiers/managers?	Yes		

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

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
Will aftercare support be provided to building occupiers?	Yes	1	1
Will seasonal commissioning occur over 12months once substantially occupied?	Yes	1	1
Will a post occupancy evaluation be carried out 1 year after occupation?	Yes	1	1
Will exemplary level criteria be met?	No	1	0

Total BREEAM credits achieved	3
Total contribution to overall building score	1.71%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Outstanding level

Comments/notes:

BREEAM®

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
Will the design provide adequate glare control for building users?	Yes	1	1
How many credits will be targeted for the daylighting criteria?	1	1	1
Will the design provide adequate view out for building users?	Yes	1	1
Will internal/external lighting levels, zoning and controls be specified in accordance with the relevant CIBSE Guides/British Standards?	Yes	1	1
Will exemplary level criteria be met?	No	1	0

Total BREEAM credits achieved	4
Total contribution to overall building score	3.53%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	N/A

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
Will an air quality plan be produced and building designed to minimise air pollution?	No	1	0
Will building be designed to minimise the concentration and recirculation of pollutants in the building?	No	1	0
Will the relevant products be specified to meet the VOC testing and emission levels required?	Yes	1	1
Will formaldehyde and total VOC levels be measured post construction?	No	1	0
Will the building be designed to, or have the potential to provide, natural ventilation?	Yes	1	1
Will exemplary level VOCs (products)criteria be met?		2	0

Key Performance Indicators: Indoor air quality

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

Comments/notes:

BREEAM®

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
Will an objective risk assessment of proposed laboratory facilities' design be completed?			
Will the manufacture & installation of fume cupboards and containment devices meet best practice standards?			
Will containment level 2 & 3 labs meet best practice safety & performance criteria?			

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

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
Will thermal modelling of the design be carried out?	Yes	1	1
Will the building design be adapted for a projected climate change scenario?	Yes	1	1
Will the modelling inform the development of a thermal zoning and control strategy?	Yes	1	1

Key Performance Indicators: Thermal comfort

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

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
Will the building meet the appropriate acoustic performance standards and testing requirements for: a. Sound insulation b. Indoor ambient noise level c. Reverberation times?	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

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
Where external site areas are present, will safe access be designed for pedestrians and cyclists?	Yes	1	1
Will a suitably qualified security consultant be appointed and security considerations accounted for?	Yes	1	1

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

Comments/notes:

ENERGY

Ene 01 Reduction of energy use and carbon emissions

No. of BREEAM credits available	12	Available contribution to overall score	9.00%
No. of BREEAM innovation credits available	5	Minimum standards applicable	Yes

How do you wish to assess the number of BREEAM credits achieved for this issue?	Enter building performance data into the Ene01 calculator

Ene 01 Calculator

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

New Construction (Fully fitted)

Building floor area	306	m2

Notional building heating and cooling energy demand	341.12	MJ/m2yr
Actual building heating and cooling energy demand	379.16	MJ/m2yr
Notional building primary energy consumption	198.38	kWh/m2yr
Actual building primary energy consumption	192.69	kWh/m2yr
Target emission rate (TER)	33.80	kgCO2/m2yr
Building emission rate (BER)	17.4	kgCO2/m2yr
Building emission rate improvement over TER	48.5%	
Heating & cooling demand energy performance ratio (EPR_{ED})	0.000	
Primary consumption energy performance ratio (EPR_{PC})	0.071	
CO_2 Energy performance ratio (EPR_{CO2})	0.367	
Overall building energy performance ratio (EPR_{NC})	0.437	

Where specified, please confirm the energy production from onsite or near site energy generation technologies	29
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	5
Total contribution to overall building score	3.75%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Excellent level

Comments/notes:

BREEAM®

Ene 02 Energy monitoring

No. of BREEAM credits available	2	Available contribution to overall score	1.50%
No. of BREEAM innovation credits available	0	Minimum standards applicable	Yes

Assessment criteria	Compliant?	Credits available	Credits achieved
Will a BMS or sub-meters be specified to monitor energy use from major building services systems?	Yes	1	1
Will a BMS or sub-meters be specified to monitor energy use by tenant/building function areas?	Yes	1	1

Total BREEAM credits achieved	2
Total contribution to overall building score	1.50%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	Outstanding level

Comments/notes:

Ene 03 External lighting

No. of BREEAM credits available	1	Available contribution to overall score	0.75%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment criteria	Compliant?	Credits available	Credits achieved
Will external light fittings and controls be specified in accordance with the BREEAM criteria?	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	0.75%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Comments/notes:

Ene 04 Low carbon design

No. of BREEAM credits available	3	Available contribution to overall score	2.25%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment criteria	Compliant?	Credits available	Credits achieved
Will passive design measures be used in line with an analysis be carried out during concept design stage (RIBA stage 2 or equivalent)?	Yes	1	1
Will free cooling measures be implemented in the whole building in line with the passive design analysis?	No	1	0
Will a LZC technology be specified in line with a feasibility study carried out by the completion of the Concept Design stage (RIBA Stage 2 or equivalent)?	Yes	1	1

KPI - Low and/or zero carbon energy generation

Total on-site and/or near-site LZC energy generation	29	kWh/yr

Total BREEAM credits achieved	2
Total contribution to overall building score	1.50%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

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
Will the refrigeration system be designed, installed & commissioned in accrodance with BREEAM criteria?	No	N/A	N/A
Will the refrigeration system demonstrate a saving in indirect greenhouse gas emissions?	No	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

Comments/notes:

Ene 06 Energy efficient transportation 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
Will a transportation system analysis be carried out to determine and specify the optimum number, size and type of lifts that is most energy efficient?			
Will the relevant energy-efficient features criteria be met?			

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

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			
Have the occupants' laboratory requirements & performance criteria been confirmed during the preparation of the initial project brief to minimise energy demand?			
Best Practice Energy Practices in Laboratories (table 27)			
Will the laboratory meet criteria item b) Fan power?			
Will the laboratory criteria item c) Fume cupboard volume flow rates?			
Will the lab meet item d) Grouping / isolation of high filtration/ventilation activities?			
Will the laboratory meet criteria item e) Energy recovery - heat?			
Will the laboratory meet criteria item f) Energy recovery - cooling?			
Will the laboratory meet criteria item g) Grouping of cooling loads?			
Will the laboratory meet criteria item h) Free cooling?			
Will the laboratory meet criteria item i) Load responsiveness?			
Will the laboratory meet criteria item j) Cleanrooms?			
Will the laboratory meet criteria item k) Diversity?			
Will the laboratory meet criteria 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

Comments/notes:

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Ene 08 Energy efficient equipment

No. of BREEAM credits available	2	Available contribution to overall score	1.50%
No. of BREEAM innovation credits available	0	Minimum standards applicable	No

Assessment criteria

Which of the following will be present and likely to be a/the major contributor to 'unregulated' energy use?	Present	Major impact
Ref A Small power and plug in equipment?	Yes	Yes
Ref B Swimming pool?		
Ref C Communal laundry?		
Ref D Data centre?		
Ref E IT-intensive operation areas?		
Ref F Residential areas?		
Ref G Healthcare?		
Ref H Kitchen and catering facilities?		

	Compliant	Credits available	Credits achieved
Will the significant majority contributor(s) to 'unregulated' energy use above meet the BREEAM criteria?	Yes	2	2

Total BREEAM credits achieved	2
Total contribution to overall building score	1.50%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

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
Will internal/external drying space and fixings be provided?			

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

Comments/notes:

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
Indicative public transport accessibility index (AI):	15.00	3	3
Will the building have a dedicated bus service?			N/A

AI	Indicative Accessibility Index for pre-assessment
0	Poor or no public transport provision
1	A single BREEAM compliant public transport node available
2	Some BREEAM compliant public transport nodes/services available
4	A selection of BREEAM compliant public transport nodes/services available
8	Good provision of public transport i.e. small urban centre / suburban area
10	Very Good provision of public transport i.e. small/medium urban centre
12	Excellent provision of public transport, i.e. medium urban centre
18	Excellent provision of public transport, i.e. large urban/metropolitan city centre

Total BREEAM credits achieved	3
Total contribution to overall building score	3.00%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

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
Will the building be in close proximity of 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

Comments/notes:

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)
How many compliant cycle storage spaces will be provided?	4
What cyclist facilities will be provided?	Showers and changing facilities

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

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)
Building's indicative Accessibility Index (sourced from issue Tra01)	15

Assessment Criteria	Compliant?	Credits available	Credits achieved
Will BREEAM's maximum parking capacity criteria for the building type/Accessibility Index be met?	Yes	2	2

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

Comments/notes:

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
Will a transport plan based on site specific travel survey/assessment be developed?	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

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

How do you wish to assess the BREEAM credits to be achieved for this issue?	Define a target % improvement over baseline sanitary fittings
What is the target for % reduction in potable water consumption for sanitary use in the building?	12.5% - one credit

Please select the calculation procedure used	

Standard approach data

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

Key Performance Indicator - use of freshwater resource

Total net Water Consumption		m3/person/yr
Default building occupancy		

Alternative approach data

Overall microcomponent performance level achieved	

Total BREEAM credits achieved	1
Total contribution to overall building score	0.88%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	Excellent level

Comments/notes:

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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
Will there be a water meter on the mains water supply to the building(s)?	Yes	1	1
Will metering/monitoring equipment be specified on the water supply to any relevant plant/building areas?	Yes		
Will all specified water meters have a pulsed output?	Yes		
If the site/building has an existing BMS connection, will all pulsed meters be connected to the BMS?	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

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
Will a mains water leak detection system be installed on the building's mains water supply?	Yes	1	1
Will flow control devices be installed in each sanitary area/facility?	No	1	0

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

Comments/notes:

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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

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

How do you wish to assess the number of BREEAM credits to be achieved for this issue?	Define the number of Mat 01 credits achieved

Assessment Criteria

Predicted total Mat01 credits achieved	3
Predicted total Mat01 points achieved	
Number of building elements assessed	
Green Guide exemplary level compliant?	
Has IMPACT compliant software been used?	

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			
Windows			
Roof			
Upper floor construction			
Internal wall			
Floor finishes/coverings			

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

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

Total BREEAM credits achieved	3
Total contribution to overall building score	3.12%
Total BREEAM innovation credits achieved	0
Minimum standard(s) level	N/A

Comments/notes:

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
Will ≥80% of all external hard landscaping and boundary protection achieve a Green Guide A or A+ rating?	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

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

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	
What is the building's targeted insulating index?	5.00	1	1	Note: An insulatio

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

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
Will suitable durability/protection measures be specified and installed to vulnerable areas of the building?	Yes	1	1
Will suitable durability/protection measures be specified and installed to exposed parts of the building?	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

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
Will material efficiency measures be identified & implemented during all RIBA stages?	Yes	1	1

Total BREEAM credits achieved	1
Total contribution to overall building score	1.04%

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

Comments/notes:

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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

How do you wish to assess the number of BREEAM credits to be achieved for this issue?	Define a target number of BREEAM credits

Select the number of BREEAM credits being targeted for issue Wst 01:	3	BREEAM Wst01 Innovation credits:	

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

Key Performance Indicators - Construction Waste		
Measure/units for the data being reported		
Non-hazardous construction waste (excluding demolition/excavation)		
Total non-hazardous construction waste generated		Note: At the pre-assessment stage this t
Non-hazardous non-demolition const. waste diverted from landfill		Note: At this stage this will be a target b
Total non-hazardous non-demolition const. waste diverted from landfill		Note: At the pre-assessment stage this t
Total non-hazardous demolition waste generated		Note: At this stage this will be a target b
Non-hazardous demolition waste diverted from landfill		Note: At this stage this will be a target b
Total non-hazardous demolition waste to disposal		Note: At the pre-assessment stage this t
Material for reuse		Note: At this stage this will be a target b
Material for recycling		Note: At this stage this will be a target b
Material for energy recovery		Note: At this stage this will be a target b
Hazardous waste to disposal		Note: At this stage this will be a target b

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

Comments/notes:

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
What is the target total % of high-grade aggregate that will be recycled/secondary aggregate?	

% 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

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
Will operational recyclable waste volumes be segregated and stored?	Yes	1	1
Will static waste compactor(s) or baler(s) be specified where appropriate?	Yes		
Will vessel(s) for composting suitable organic waste where appropriate?	Yes		

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

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
No speculative floor or ceiling finishes will be specified in the building	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

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
Will a climate change adaptation strategy appraisal for structural and fabric resilience be conducted by the end of Concept Design (RIBA Stage 2 or equivalent)?	No	1	0
Will exemplary level criteria – Responding to adaptation to climate change be met?	No	1	0

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

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
Will a building specific functional adaptation strategy appraisal be conducted by Concept Design (RIBA Stage 2 or equivalent) and will functional adaptation measures be implemented?	No	1	0

Total BREEAM credits achieved	0

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

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

Assessment Criteria	Compliant?	Credits available	Credits achieved
Will at least 75% of the proposed development's footprint be located on previously occupied land?	Yes	1	1
Is the site deemed to be significantly contaminated?	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

Comments/notes:

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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	Please select

Assessment Criteria	Compliant?	Credits available	Credits achieved
Can the land within the construction zone be defined as 'land of low ecological value'?	Yes	1	1
Will all features of ecological value surrounding the construction zone/site boundary be protected?	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

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

What is the likely change in ecological value as a result of the sites development?	≥0 species (i.e. no negative change)	Plant species richn

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

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	
Will a suitably qualified ecologist be appointed to report on enhancing and protecting site ecology?	Yes	2	1	
Will the suitably qualified ecologist's general recommendations be implemented?	Yes			
What is the targeted/intended improvement in ecological value as a result of enhancement actions?	Please select			Plant species richr

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

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
Will a Suitably Qualified Ecologist be appointed to monitor/minimise impacts of site activities on biodiversity?	Yes	2	2
Will a landscape and habitat management plan be produced covering at least the first five years after project completion in accordance with British Standards?	Yes		
Number of applicable measures to improve biodiversity confirmed by SQE:	4		
Number of applicable measures implemented:	4		

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

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?	No	3	3
Do all systems (with electric compressors) comply with the requirements of BS EN 378:2008 (parts 2 & 3) & where refrigeration systems containing ammonia are installed, the IoR Ammonia Refrigeration Systems Code of Practice?			
Global Warming Potential of the specified refrigerant(s) 10 or less?			
What is the target range Direct Effect Life Cycle CO2eq. emissions for the system?		kgCO2eq/kW coolth capacity	
Cooling/Heating capacity of the system		kW	
Will a refrigerant leak detection and containment system be specified/installed?		0	0

Total BREEAM credits achieved	3
Total contribution to overall building score	2.31%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

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	45.00	mg/kWh
NO_x emission level - cooling	0.00	mg/kWh
NOx emission level - water heating	0.00	mg/kWh
Does this building meet BREEAM's definition of a highly insulated building?	N/A	
Energy consumption: heating and hot water		kWh/m2 yr

Total BREEAM credits achieved	2
Total contribution to overall building score	1.54%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

Comments/notes:

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
What is the actual/likely annual probability of flooding for the assessed site?	Low	2	2
Will a Flood Risk Assessment be undertaken?	Yes		
Will the site meet the BREEAM criteria for peak rate surface water run off?	Yes	1	1
Will the site meet the criteria for surface water run off volume, attenuation and/or limiting discharge?	Yes	1	1
Will the site be designed to minimise watercourse pollution in accordance with the BREEAM criteria?	Yes	1	1

Total BREEAM credits achieved	5
Total contribution to overall building score	3.85%
Total BREEAM innovation credits achieved	N/A
Minimum standard(s) level	N/A

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
Will the external lighting specification be designed to reduce light pollution?	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

Comments/notes:

BREEAM®

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
Will there be noise-sensitive areas/buildings within 800m radius of the development?	Yes	1	1
Will a noise impact assessment be carried out and, if applicable, noise attenuation measures specified?	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

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	No	3	0
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?	0

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

Comments/notes:

Mounting systems for solar technology

K2 SYSTEMS

CALCULATION BASIS

PROJECT:	Informer House
DRAFTSMAN:	Russell
DATE:	03/05/2016

INFORMATION

PROJECT DATA

Project Name: Informer House

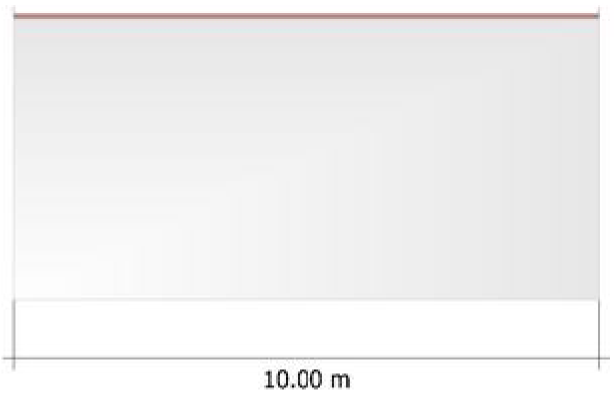
BUILDING DATA

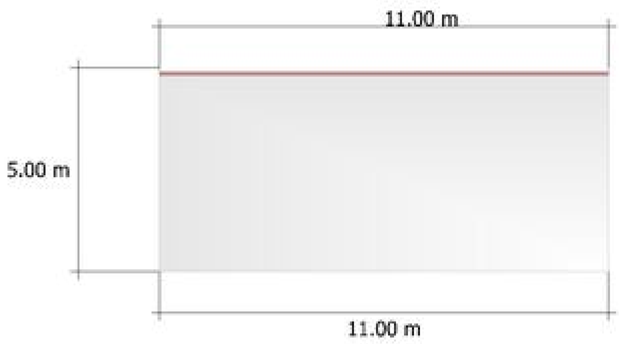
LOCATION

Ground level 100 m

BUILDING TYPE

Building Length	10.00 m
Building Width	11.00 m
Building Height	5.00 m
Parapet Wall Heigh	0.20 m
Roof Slope	0 °
Friction Coefficient	0.50





LOADS

SNOW LOAD

Snow Load Zone: 3

Shape Coefficient Relating To Snow: m_1 = 0.800

Snow Load On Ground: s_k = 0.500 kN/m²

Snow Load: s_i = 0.400 kN/m²

WIND LOAD

Wind Velocity:	$v_{b,map}$ 22.0 m/s
Terrain Category:	Urban area
Distance to shoreline:	a = 50.0 km
Distance Inside Town:	a = 10.0 km
Gust Velocity Pressure:	q_p = 0.502 kN/m²

ROOF AREAS

Area	Displacement Verification		Uplift Verification
	cpe_vert	cpe_hor	cpe
01 (18..48 Modules)	-0.180	0.330	-0.180

DEAD WEIGHT

Modul Area:	A_M = 1.64 m²
Module Weight:	G_M = 21.00 kg
Dead Weight:	g_M = 0.125 kN/m²

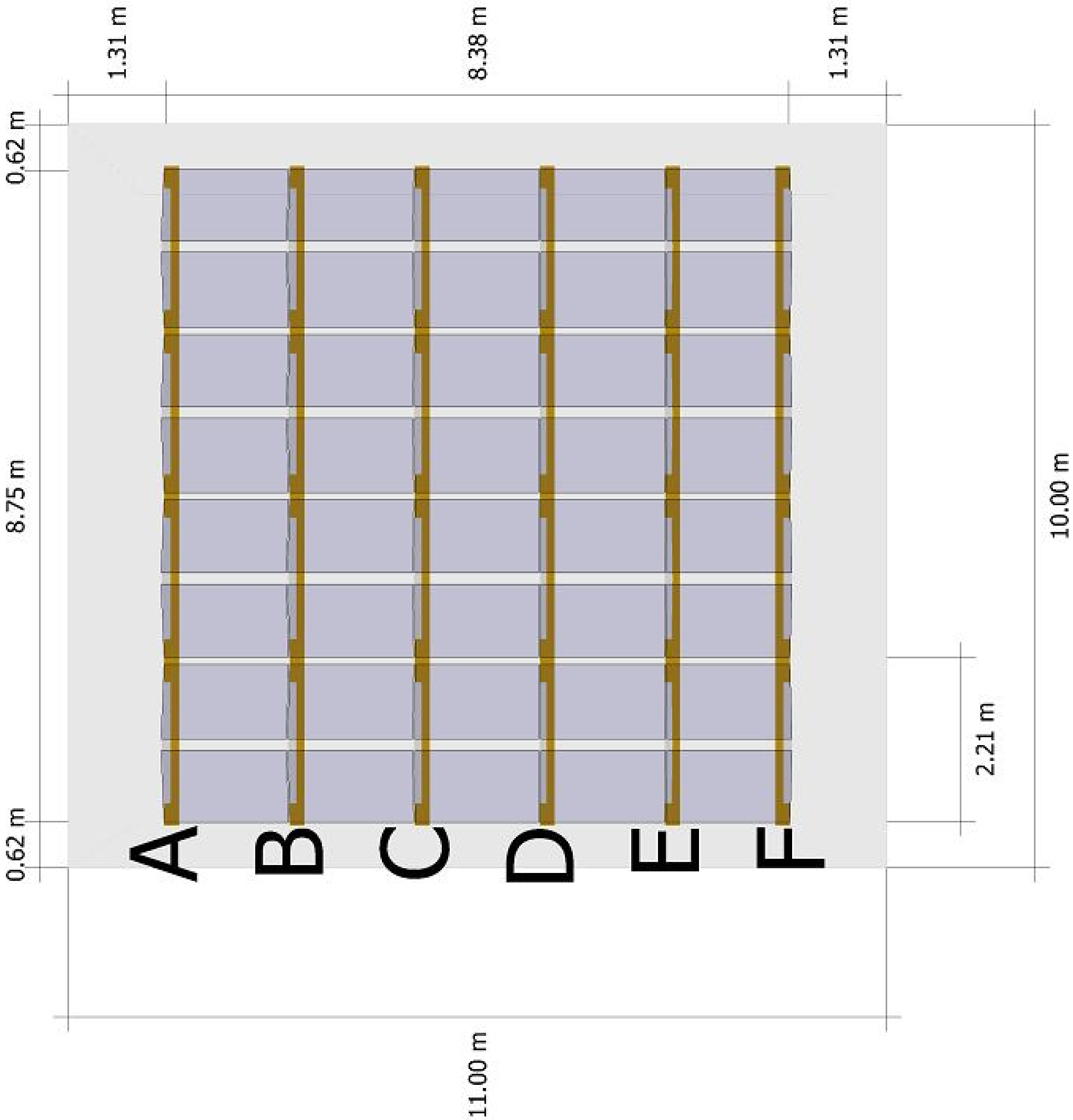
LOAD COMBINATION

Partial Safety Coefficient Permanent:	g_G = 1.35
Partial Safety Coefficient First Variable:	g_{Q1} = 1.50
Partial Safety Coefficient N Variables:	g_{Qn} = 1.50
Partial Safety Coefficient Exceptional:	g_A = 1.00
Combination Coefficient Relating To Wind:	$y_{0,W}$ = 0.60
Combination Coefficient Relating To Snow:	$y_{0,S}$ = 0.50
Combination Coefficient Relating To Snow 1000 M Above Sea Level:	$y_{0,S}$ = 0.70

Lk1:	$E_d = 1.35 * G_k + 1.50 * S_k$
Lk2:	$E_d = 1.35 * G_k + 1.50 * W_{k,Pressure}$
Lk3:	$E_d = 1.35 * G_k + 1.50 * (W_{k,Pressure} + 0,5 * S_k)$
Lk4:	$E_d = 1.35 * G_k + 1.50 * (S_k + 0,6 * W_{k,Pressure})$
Lk5:	$E_d = G_k + A_d + 0,2 * W_{k,Pressure}$
Lk6:	$E_d = G_k + 1.50 * W_{k,Suction}$
Uplift Verification:	$E_d = 0.9 * G_k + 1.25 * W_{k,Suction}$
Displacement Verification:	$E_d = 0.9 * G_k + 1.10 * W_{k,Suction}$

ROOF STRUCTURE

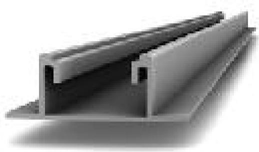
Modules:	40	Module Length:	1660 mm
		Module Width:	990 mm
		Module Height:	50 mm
		Module Weight:	21.00 kg


1.31 m
8.38 m
1.31 m
0.62 m
8.75 m
0.62 m
10.00 m
2.21 m
A
B
C
D
E
F
11.00 m

CONFIGURATION

Rails

Description	K2 SpeedRail 22
Moment Of Inertia Iy	1.53 cm4
Moment Of Inertia Iz	7.74 cm4
Section Modulus Wy:	1.08 cm^3
Section Modulus Wz:	2.46 cm^3



LAYOUT

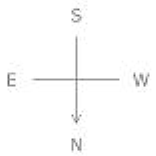
DESIGN GUIDE

- Base Rail

Base Rail A - F: 1x 6.10 m; 1x 3.15 m (Cut To 2.75 m)

Ballast accessory

A Short Porter (1.88 kg)
B Short Porter (3.77 kg)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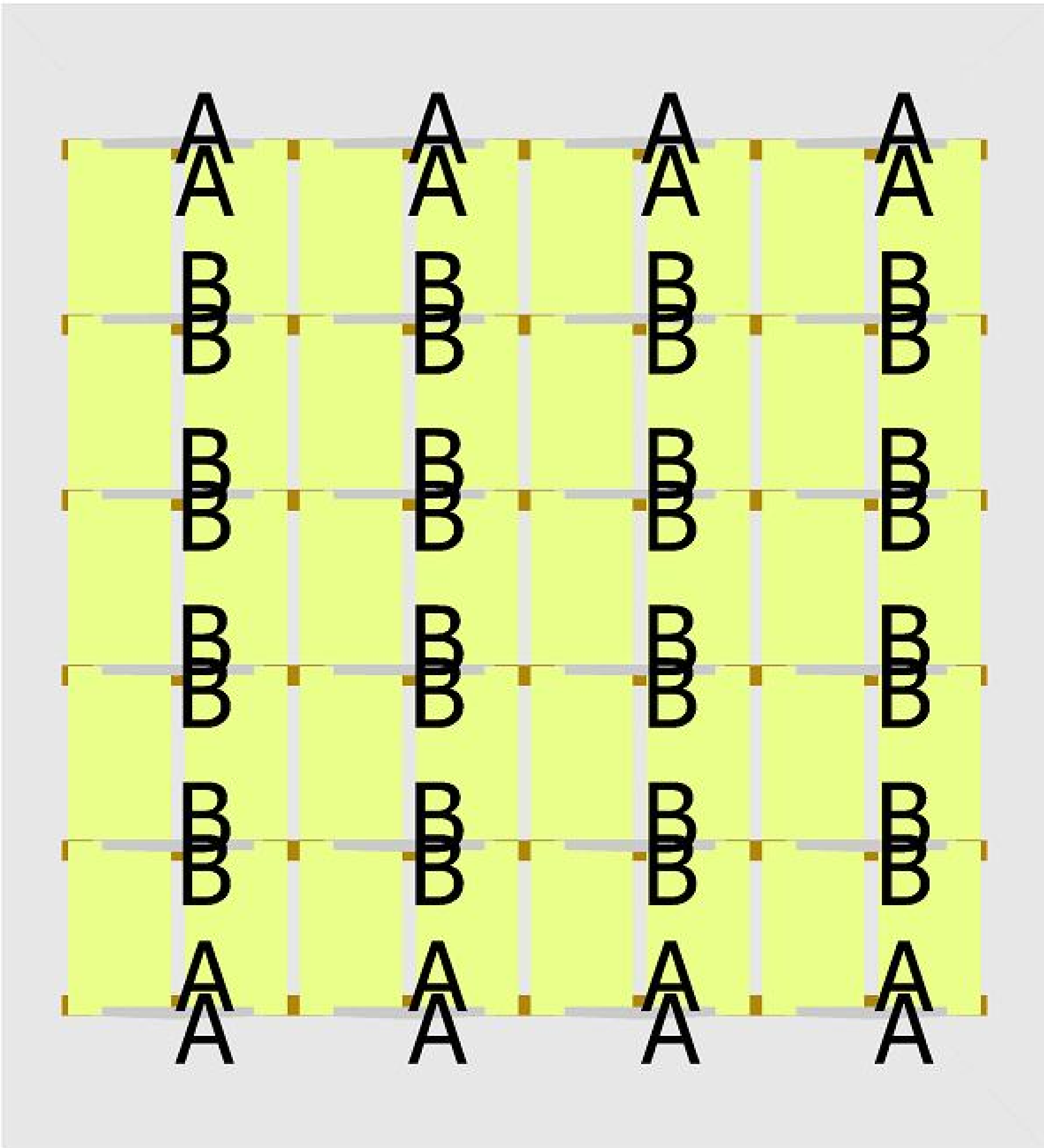
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MAXIMUM UTILIZATION

Centre distance basic profiles:	1.680 m
Load Assumption On Module:	1.27 kN/m²
System Utilisation:	14.16 %

Area	Ballasting [kg] per double module	Total Weight [kg/m²] (projected module area)	Quantity Of Modules
I	7.54	14.33	40

Total weight refered to entire roof area: 10.95 kg/m²
This value results from the entire ballast, module weight and dead weight of the mounting system divided by the entire roof area.

THE SYSTEM HAS BEEN CALCULATED SUCCESSFULLY.

CALCULATION NOTICE

¬ The analysis is only made for the substructure. The rails are considered as multi span beams with a cantilever using evenly distributed loads.
¬ Please assure that module used has got the module manufacturers approval for the Dome-Systems. View the latest list of approved modules here: http://www.k2-systems.com/en/downloads/approved-module-list.html.
¬ The design rules comply with the EUROCODE BS EN 1990 - Basis of structural design.
¬ The determination of wind loads is based on the national annex to BS EN 1991-1-4: 2005 - Wind Loads. The different sections have been combined for clarity.
¬ The determination of the snow load is based on the national annex to BS EN 1991-1-3: 2003 - Snow loads. Any snow bag possibility has to be considered by a higher snow load.
¬ The values of the material load capacity are taken from the manufacturer's technical handbook.
¬ With any roof pitch of more than 3° the system additionally has to be mechanically fastened.

BILL OF MATERIAL

Position	Number	Article	Quantity	Weight
1	2001695	K2 BSP Wing Solar Alu 470x180 18mm	24	24.000 kg
2	2001739	K2 BSP Wing Solar Alu 160x180 18mm	48	16.800 kg
3	1001163	K2 SpeedRail 22; 6,10 m	6	23.420 kg
4	2001905	K2 SpeedRail 22; 3,15 m	6	12.150 kg
5	1006039	K2 connector SpeedRail/FlatRail Set	6	1.940 kg
6	1005840	K2 Dome D1000	24	31.200 kg
7	1005842	K2 Dome SD	48	15.360 kg
8	2001729	Hexagonal socket head cap screw DIN 912/EN ISO 4762, M8x20, SER, A2-70	96	2.600 kg
9	1001643	M K2 Slot nut with clip, Stainless steel	96	1.750 kg
10	2001946	Dome Short Porter Set	48	18.300 kg
11	2000081	K2 Dome Porter	40	56.000 kg
12	2000155	K2 Dome Porter screw SET	40	2.376 kg
13	1005149	K2 Set Middle Clamp, 49-50mm	64	5.184 kg
14	1005172	K2 Set End Clamp 49-50mm	32	2.400 kg
Sum				213.48 kg