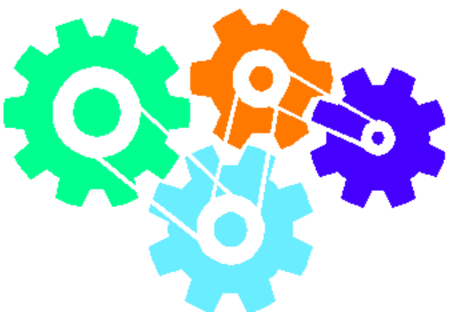
2014

Energy Strategy Report [Clifford Pugh House, 5-7 Lancaster Grove, London, NW3]



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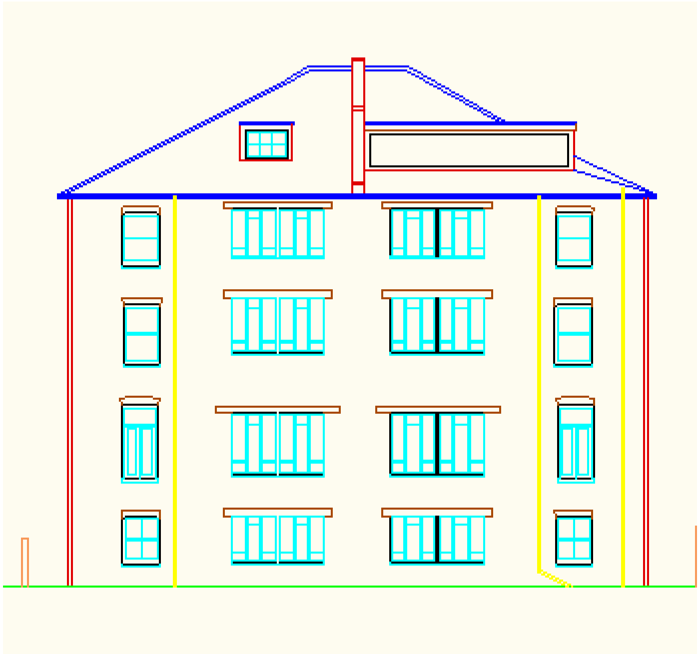

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1. Executive Summary

The design of the proposed development in **Clifford Pugh House, 5-7 Lancaster Grove, London, NW3**, will be comprised of **8No Refurbished Residential units** located in London. The design has incorporated building fabric enhancement (above current building regs 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.

Given the complexity of calculating and assessing CO_2 emissions, the **Camden Council** requires all proposed developments to incorporate sustainable design and construction measures. **All buildings, whether being updated or refurbished, are expected to reduce their carbon emissions by making improvements to the existing building. Work involving a change of use or an extension to an existing property is included. As a guide, at least 10% of the project cost should be spent on the improvements. Sensitive improvements can be made to historic buildings to reduce carbon dioxide emissions (CPG3 - Energy Efficiency: Existing Buildings)**. Schemes must: demonstrate how sustainable development principles have been incorporated into the design and proposed implementation. According to the Camden Planning Guidance, **it is requested that the creation of 5 or more dwellings from an existing building will need to be designed in line with EcoHomes/ BREEAM Domestic Refurbishment "EXCELLENT" rating as a minimum requirement, by achieving the minimum standards for specific categories (% of un-weighted credits) of 60% of the credits achieved under the Energy and Water and 40% under the Materials sections** in accordance with the Development Policy DP22: Promoting sustainable design and construction & the CPG3: Sustainability Assessment Tools (9.12). Also, according to the CS13 policy, **developments need to achieve a reduction in CO_2 emissions of 20% from on site renewable energy generation, unless it can be demonstrated that such provision is not feasible.**

The recommendation for the proposed development is that **Efficient Communal Air Source Heat Pumps should be progressed for the residential units. In addition, a total of 5.232kWp PV (which equals to 16 PV panels in total and approximately 25.6m^2 total required roof area) should be progressed for the whole development.** This is based on the following reasons:

1. The strategy would provide an average of **74.50% CO_2 reduction from the Existing Building to the proposed converted and refurbished residential units. Therefore, the strategy meets BRUK-L1B 2013 requirements for the development.**

2. The development is located within a Conservation area. This has been taken into consideration and hence the proposed renewables (PVs) have been only placed on the part of the roof which is not visible from the street. Thus a total area of 25.6 m^2 has been allocated to the installation of PVs. The strategy would provide **an average 14.41% reduction of CO_2 emissions the energy demand via onsite renewable technology (PV) for the overall development. Hence, a relaxation for the 20% target is being requested.**

3. A separate BREEAM Domestic Refurbishment (previously EcoHomes) pre-assessment has been undertaken for the refurbished residential units of the development. **The BREEAM pre-assessment**

demonstrates that an "Excellent" rating can be achieved for all the dwellings [See the Appendix for the BREEAM pre-assessment report].

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

	Carbon Dioxide emissions (Tonnes CO_2 per annum)
	Regulated
Existing Building	48.11
After energy demand reduction	19.13
After CHP/ Communal Heating	14.33
After renewable energy	12.26

Table 1: Carbon dioxide Emissions after each stage of the Energy Hierarchy

The chart below summarizes the regulated carbon dioxide savings from each stage of the Energy Hierarchy:

	Regulated Carbon Dioxide savings	
	(Tonnes CO_2 per annum)	**(%)**
Savings from energy demand reduction	28.92	60.23%
Savings from CHP/ Communal Heating	4.79	25.09%
Savings from Renewable energy	2.07	14.41%
Total Cumulative Savings	**35.78**	**74.50%**
Total Target Savings	**0.48**	**>1%**
Annual Surplus	**35.30**	

Table 2: Regulated carbon dioxide savings from each stage of the Energy Hierarchy

The key metrics currently envisaged for the development are listed below:

- **The carbon saving attributable to energy efficiency measures:** 60.23 %
- **The carbon saving attributable to clean measures:** 25.09 %
- **The carbon saving attributable to renewable energy technologies:** 14.41 %
- **The proposed development's overall improvement over the Existing building baseline:** 74.50 % - As can be seen from the table above, the development meets the 35% target.

5. **Meeting the BREEAM Policy Requirements:**

- The overall score is **72.77**, thus achieving **BREEAM Excellent**.
- Under the **Energy category**, the development achieves **24 credits out of 29 credits** available (more than 60% of the planning policy required credits).
- Under the **Water category**, the development achieves **4.5 credits out of 5 credits** available (60% of the planning policy required credits).
- Under the **Materials category**, the development achieves **23 credits out of 45 credits** available (more than 40% of the planning policy required credits).

2. Introduction

Syntegra Consulting Ltd has been appointed as energy consultants to produce an energy strategy for the **'Development consisting of 8No. Refurbished Residential units'** for the scheme at **Clifford Pugh House, 5-7 Lancaster Grove, London, NW3** – to support the scheme design process, demonstrate Building regulations Part L1B 2013 compliance and intent to target a 20% reduction of CO_2 emissions reduction via onsite renewable energy technology for the overall development in accordance with the planning policy requirements.

This report will outline the following:

1) This report will assess the proposed development site's estimated energy demand & CO2 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 **BREEAM Domestic Refurbishment pre-assessment strategy** in terms of the intent in achieving the **overall minimum rating of "EXCELLENT"** for the development. –In accordance with the London Plan 2011 and local planning policy targets.

3) The proposed building fabric and Low Zero Carbon (LZC) design strategy and analysis calculations, with respect to the Standard Assessment energy assessment Procedure (SAP). The comparison of the development's energy consumption against the existing building model in order to show a minimum target for the overall development **against current 2013 Part L1B building regulations**.

4) The target of **a 20% reduction of the development's CO_2 Emissions** through the utilisation of renewable technology as per the planning policy requirements.

3. Site Description

The proposed four storey development will be comprised of **8No. Refurbished Residential Units (Flats)**. The development is located in the area of Camden in London and it is in close proximity to Swiss Cottage Underground station (approx 0.3 miles) and to Finchley Road Underground station (approx 0.5 miles). The site is within the London Borough of Camden.

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 2011 (Policy 5.2, 5.6 & 5.7)

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 5.42 section of Policy 5.7 Renewable Energy (which can include sources of decentralised renewable energy). According to Policy 5.2 (clause B) all residential and non-residential buildings should show an improvement of 40% BER/TER from 2013 to 2016, unless it can be demonstrated that such provision is not feasible. Furthermore, intent must be shown for connecting to a Decentralised energy Network according to Policy 5.6 and utilizing a Combined Heat & Power.

4.3. Camden Council

Camden

Camden Development Policies
Section 3 - A sustainable and Attractive Camden

Policy DM22: Promoting Sustainable Design and Construction

The Council will require development to incorporate sustainable design and construction measures. Schemes must:

a. demonstrate how sustainable development principles, have been incorporated into the design and proposed implementation; and
b. incorporate green or brown roofs and green walls wherever suitable.

The Council will promote and measure sustainable design and construction by:

a. adopting the government target that all new build housing will be zero carbon by 2016 (Code for Sustainable Homes Level 6), along with the stepped targets of Code 3 by 2010 and Code 4 by 2013;
b. **expecting developments (except new build) of 500sqm of residential floor space or above or 5 or more dwellings to achieve 'excellent' in EcoHomes assessments from 2013 and at least 'very good' prior to 2013**;
c. expecting non-domestic developments of 500sqm of floor space or above to achieve 'very good' in BREEAM assessments, with the aim of increasing the target to a rating of at least 'excellent' in 2016, if feasible, and zero carbon from 2019, in line with the government's ambitions.

The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:
a. summer shading and planting;
b. limiting run-off;
c. reducing water consumption;
d. reducing air pollution; and
e. not locating vulnerable uses in basements in flood-prone areas.

Camden Planning Guidance – Sustainability CPG3

Core Strategy policy CS13 – Tackling climate change through promoting higher environmental standards

This policy encourages developments to meet the highest feasible environmental standards that are financially viable during construction and occupation. **All developments will be expected to achieve a 20% reduction in carbon dioxide emissions from on-site renewable energy generation** unless it can be demonstrated that such provision is not feasible. The 20% reduction should only be attempted once stages 1 and 2 of the energy hierarchy have been applied.

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 states that 'The following hierarchy should be used to assess applications:

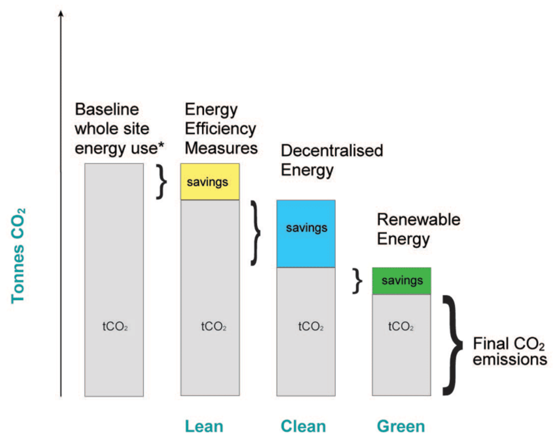
- *Using less energy, in particular by adopting sustainable design and construction measures;*
- *Supplying energy efficiency, in particular by prioritising decentralised energy generation; and*
- *Using renewable energy.*

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.



5. The development configuration scheme

The proposed development scheme consists of the following characteristics:

5.1. The Unit Configuration

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

Proposed units to be assessed for the development:

No. of Units	Type of unit	Floor	Number of bedrooms	Individual Dwelling Area m^2
1	Flat 1	Ground Floor	1	56.0
2	Flat 2	Ground Floor	1	56.0
3	Flat 3	1st Floor	2	82.5
4	Flat 4	1st Floor	2	82.5
5	Flat 5	2nd Floor	2	82.5
6	Flat 6	2nd Floor	2	82.5
7	Flat 7	3rd and 4th Floor	3	130.5
8	Flat 8	3rd and 4th Floor	3	130.5
Total	**-**	**-**	**16**	**703**

Table 1

5.2. Specification of Building Materials

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

Building Envelope Specification

Building Element	Existing Specification	Proposed Specification
External Walls U-value	2.3	0.25 (upgraded)
Window units (whole window) U-value	4.8 Single glazing	1.4 double glazing
Floor U-value	1.2	0.2 (upgraded)
Flat & Pitched Roof U-value	2.3	0.16 (upgraded)
Air Permeability m^3/(h.m^2) at 50 Pa	15.0	15
Low Energy Lighting	15%	100%

Table 2

5.3. Fuel

The assessment has assumed the following fuel carbon emissions factors. The fuel carbon emissions factors used are in accordance with **SAP 2012 (for Building Regs Part L1B 2013).**

Carbon Emissions Factor	SAP 2013 kgCO2/kW
Grid Electricity	0.519
Coal (traditional British Coal)	0.394
Heating Oil	0.298
LPG	0.241
Natural Gas	0.216
Wood Pellets	0.039
Bio Diesel	0.123
Petrol	0.098

Table 3

6. Baseline CO_2 Emissions

The baseline energy use and resulting CO_2 emissions rates of the development have been assessed using the SAP 2012 Government approved software. The SAP 2012 calculations have been produced according to the ADL1B 2013 building regulation requirements.

For the purpose of this report the baseline energy use and CO_2 emissions for the development are calculated based on the minimum requirements specified in the Building Regulations ADL1B 2013 document (Table 4).

	ADL1B 2013 min. required values	Proposed building values
Air Permeability $m^3/(h.m^2)$ at 50 Pa	10	15
Wall U value W/m^2C^0	0.3	0.25
Roof U value W/m^2C^0	0.18	0.16
Floor U value W/m^2C^0	0.25	0.2
Window U value W/m^2C^0	2	1.4

Table 4

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

Building Services	Existing Building CO_2 Emissions (kg $CO_2/m^2/yr$)
Heating	64.99
Auxiliary	0.08
Lighting	1.52
Hot Water	1.82
Total regulated emissions	**68.42**

Building Services	Baseline CO_2 Emissions (kg $CO_2/m^2/yr$)	Baseline CO_2 Emissions (Tonnes CO_2/ yr)
Total regulated emissions (heating, hot water, lighting, fans & pumps)	**68.42**	**48.11**

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 ADL1A 2013 document.
2. Designing for a buildings air permeability exceeding ADL1A 2013 target values.
3. Utilising the highly efficient heating and hot water systems.
4. Utilising low energy efficient lighting such as LED lighting.

7.1. Heating 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 Combi Gas Boilers have been examined for the heating and hot water demand. This strategy utilizes Individual Combi gas boilers in each dwelling to provide heating and DHWS - (90% efficiency).

7.2. Ventilation

A natural supply ventilation strategy will be adopted in all dwellings with extract fans in bathrooms and kitchens. Therefore, higher energy consumption and CO_2 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.

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

Option 1: Combi gas boilers BE LEAN stage

Building Services	Existing Building CO_2 Emissions (kg $CO_2/m^2/yr$)	BE LEAN Building CO_2 Emissions (kg $CO_2/m^2/yr$)
Heating	64.99	17.24
Auxiliary	0.08	0.44
Lighting	1.52	2.22
Hot Water	1.82	7.31
Total regulated emissions	**68.42**	**27.21**

CO_2 Reductions after BE LEAN stage

Regulated Emissions	Baseline CO_2 Emissions	BE LEAN Building CO2 Emissions	% reduction in CO_2 Emissions
kgr of $CO_2/m^2/yr$	**68.42**	**27.21**	
Tonnes CO_2/ yr	**48.11**	**19.13**	**60.23%**

From the table above it can be seen that the overall CO_2 reduction due to energy efficiency is ***60.23%*** for the total emissions.

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

- Wall u-value = 0.25 (better than Building Regs PartL1B)
- Floor u-value = 0.2 (better than Building Regs PartL1B)
- Roof u-value = 0.16 (better than Building Regs PartL1B)
- Windows u-value = 1.4 - double glazing (better than Building Regs PartL1B)
- 100% energy efficient lighting
- Combi gas boilers (90% efficiency)

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.

A CHP system has not been considered for this development.

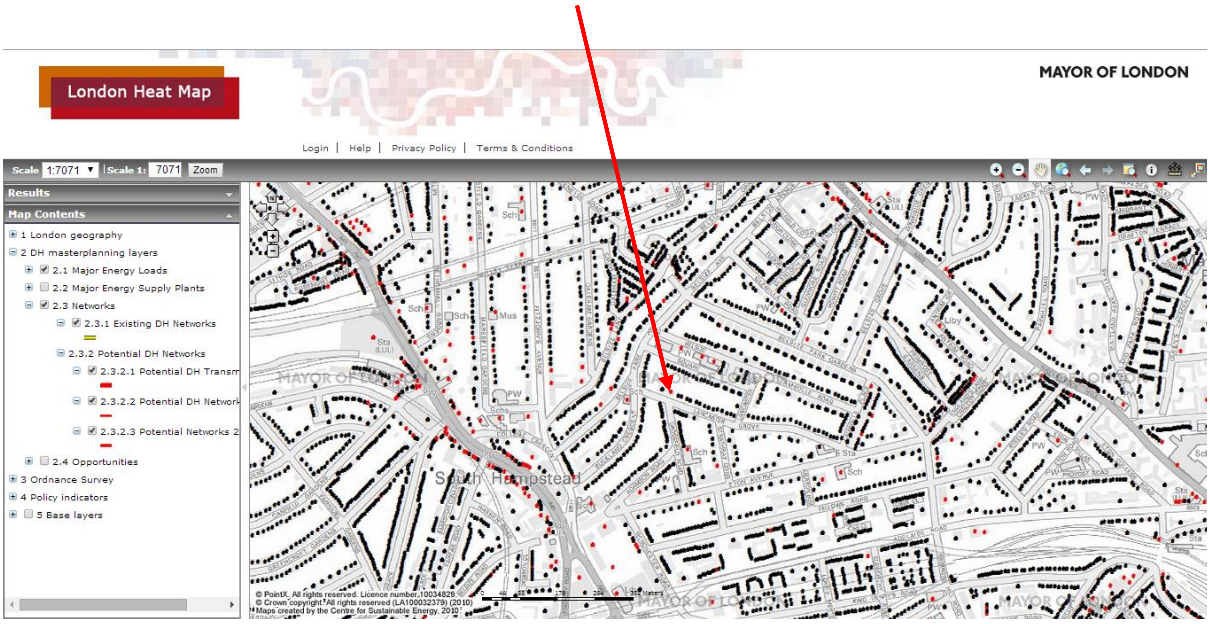
8.2. Micro-CHP

Micro CHP has not been considered further for this project due to the following reasons:
Micro-CHP is a relatively new concept (Baxi Ecogen was made available in 2009) 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 other issues surrounding the fact that around 50% of electricity generated in domestic properties is surplus, 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 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 Camden (September 2007)** as part of this assessment. The study does not identify the area in Lancaster Road as a high potential area for a District Heating network. The development is not adjacent enough to the existing or the future District Heating transmission line. The costs involved in extending the potential DH network would outweigh the advantages achieved from such a connection due to the size of the development. This is demonstrated clearly from the London Heat Map (http://www.londonheatmap.org.uk) snapshot below.

Site Location



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 option of installing **Communal Gas Boilers (95% efficiency) has been examined for the residential units**. **This strategy utilizes a communal boiler system to provide heating and DHWS to all dwellings via a Heat Interface Unit (HIU) installed in each dwelling. It also has the flexibility to allow for future connections to a District heating system via plate heat exchangers. Space needs to be allowed at this stage for future plant.**

Option 1: Communal gas boilers BE CLEAN stage

Building Services	BE LEAN Building CO_2 Emissions (kg $CO_2/m^2/yr$)	BE CLEAN Building CO_2 Emissions (kg $CO_2/m^2/yr$)
Heating + Hot Water	24.55	23.7
Auxiliary	0.44	0.00
Lighting	2.22	2.22
Total regulated emissions	**27.21**	**25.93**

CO_2 Reductions after BE CLEAN stage

Regulated Emissions	BE LEAN Building CO_2 Emissions	BE CLEAN Building CO_2 Emissions	% reduction in CO_2 Emissions
kgr of $CO_2/m^2/yr$	27.21	25.93	
Tonnes CO_2/ yr	19.13	18.23	4.7%

From the table above it can be seen that the overall CO_2 reduction due to energy efficiency is ***4.7%*** for the total emissions.

The option of installing **Communal Air Source Heat Pumps (320% efficiency) has been examined for the residential units**. **This strategy utilizes communal air source heat pumps to provide heating and DHWS to all dwellings.**

Option 2: Communal ASHP BE CLEAN stage

Building Services	BE LEAN Building CO_2 Emissions (kg $CO_2/m^2/yr$)	BE CLEAN Building CO_2 Emissions (kg $CO_2/m^2/yr$)
Heating + Hot Water	24.55	18.17
Auxiliary	0.44	0.00
Lighting	2.22	2.22
Total regulated emissions	**27.21**	**20.39**

CO_2 Reductions after BE CLEAN stage

Regulated Emissions	BE LEAN Building CO_2 Emissions	BE CLEAN Building CO_2 Emissions	% reduction in CO_2 Emissions
kgr of $CO_2/m^2/yr$	27.21	20.39	
Tonnes CO_2/ yr	19.13	14.33	25.09%

From the table above it can be seen that the overall CO_2 reduction due to energy efficiency is ***25.09%*** for the total emissions.

9. BE GREEN – Renewable Energy

In this section the viable renewable energy technologies that will reduce the development's CO_2 emissions further by 20% are examined. Incorporating lean design measures will significantly reduce the onsite energy consumption and the CO_2 emissions of the building however the reduction in emissions is still short of the target set out in the 'London Plan'. The 'London Plan' also states that a 20% CO_2 reduction must be achieved by the installation of renewable technologies. 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:

- Wind Turbines [See Appendix Section 11.1]
- Biomass Boilers [See Appendix Section 11.2]
- Hydrogen Fuel Cells [See Appendix Section 11.3]
- Small scale hydro power [See Appendix Section 11.4]
- Grd. Source Heat Pump (GSHP) [See Appendix Section 11.5]
- CHP & Micro CHP [See Appendix Section 11.6]
- Solar Thermal

9.1. Air Source Heat Pumps & Photovoltaic (PV) – Proposed Technologies

Air Source Heat Pumps and Photovoltaic panels are the proposed renewable technologies for the proposed development.

PV panels are being proposed as a renewable technology for this development. The PV system will provide self-generating electricity which can be sold back to the grid. The CO_2 reduction via renewables target is achieved with the implementation of PV. For the calculation of the payback period, the Feed-In-Tariffs' (FITs) has been taken into account. The PV load falls within the bracket associated with a FIT tariff applied of 13.03p per kWh for electricity generated and 4.77p per kWh for electricity exported back to the grid (over 20 years).

Air source heat pumps absorb heat from the outside air. This heat can then be used to heat radiators, underfloor heating systems, or warm air convectors and hot water in your home. An air source heat pump extracts heat from the outside air in the same way that a fridge extracts heat from its inside. It can get heat from the air even when the temperature is as low as -15° C. Heat pumps have some impact on the environment as they need electricity to run, but the heat they extract from the ground, air, or water is constantly being renewed naturally. Installing a typical system, costs around £7,000 to £14,000. Running costs will vary depending on a number of factors - including the size of your home, and how well insulated it is, and what room temperatures you are aiming to achieve.

Hence, the target of 20% CO_2 reduction via renewable onsite can be achieved with the implementation of the following options:

<u>For the residential units three options have been examined</u>:

- **Option 1: Communal Gas Boilers + Photovoltaic panels**
- **Option 2: Communal ASHP + Photovoltaic panels**

PV System specification - Whole Development

The PV system capacity for the whole development depends upon the selection of the three heating systems outlined at the 'BE LEAN' and at the 'BE CLEAN' stage of the energy hierarchy.

Therefore, the amount of PV's relating to the heating system options is outlined below:

- **Option 1 : Communal Gas Boilers + Photovoltaic panels + 5.232kWp**

The tables below illustrate the site and the PV panel's details:

Orientation	South	**Number of Panels**	**16**
Panel Tilt	Horizontal	**Manufacturer**	Sunpower
Overshading	Less than 20 percent	**Model**	SPR 327NE WHT D
Proportion Exported	50%	**Type**	Monocrystalline
Build Type	New	**Area**	1.631 m^2
Energy Efficiency	EPC valid and at least Band D or higher	**Power Output**	327 Wp
Installation Type	Not a multi-installation		

System Specification :	**5.232 kWp**
Total Roof Area Required :	**25.6 m^2**
Annual Electricity Ouput :	**4515.22kWh**

This table above shows the proposed PV specification for the refurbished residential units. It will generate 4515.22kWh per year. For the 5.232kWp system, 16 high efficiency 327W monocrystalline PV panels need to be installed. The roof area required for the PV panels is approximately 25.6m^2.

5.232 kWp Solar PV for ROI model below

Note: PV panels are based on high output, high efficiency at 327 Watts/panel.

Investment in 5.28kWp System: *		£ 8,651.50
First Year:	Income from Feed-In Generation Tariff @ 13.03p/kWh:	£ 575.11
	Income from exporting energy @ 4.77p/kWh:	£ 105.27
	Electricity Saving:	£ 317.79
	Total Benefit:	£ 998.17
Payback Time:		7y 7m
Total Profit Over 20 years:		**£ 20,516.07 11.86 % per year (6.08% AER)**

Assumptions:

- Illustrative solar PV performance figures only. Figures are given in good faith but do not constitute "Financial Advice".
- Exact PV subsidy figures may depend on grants available at particular locations and other factors.
- Your property has an Energy Performance Certificate (EPC) rating of level D or better.
- Yearly PV output uses a factored degradation over time based on industry estimates.
- Tariffs shown presume installation after at the new FiT rates
- VAT is included (at 5% where appropriate) unless a new build is specified.
- Photovoltaic Panels will not be shaded (e.g. by Trees or Buildings) as shading affects PV output.
- Exact equipment costs are estimated based on retail prices in 2012 and will vary by installer/supplier.
- Installation costs are based on industry averages for installation type/size. Every install is different and you should obtain 3 uotes.
- Assuming that you pay 14.4p per unit and that around 35% of the solar electricity that you generate will be used in your home, having an export meter (you can change such assumptions above).

In order to qualify both the installer and the equipment must be certified under the Microgeneration Certification Scheme (MCS).

PV plant location(s) – To be located on the roof area.

Option 2 : Communal Air Source Heat Pumps + 5.232kWp

The tables below illustrate the site and the PV panels details:

Orientation	South	Number of Panels	16
Panel Tilt	Horizontal	Manufacturer	Sunpower
Overshading	Less than 20 percent	Model	SPR 327NE WHT D
Proportion Exported	50%	Type	Monocrystalline
Build Type	New	Area	1.631 m^2
Energy Efficiency	EPC valid and at least Band D or higher	Power Output	327 Wp
Installation Type	Not a multi-installation		

System Specification :	**5.232 kWp**
Total Roof Area Required :	**25.6 m^2**
Annual Electricity Ouput :	**4515.22kWh**

This table above shows the proposed PV specification for the new residential units. It will generate 4515.22kWh per year. For the 5.232kWp system, 16 high efficiency 327W monocrystalline PV panels need to be installed. The roof area required for the PV panels is approximately 25.6m^2.

5.232 kWp Solar PV for ROI model below

Note: PV panels are based on high output, high efficiency at 327 Watts/panel.

Investment in 5.28kWp System: *		£ 8,651.50
First Year:	Income from Feed-In Generation Tariff @ 13.03p/kWh:	£ 575.11
	Income from exporting energy @ 4.77p/kWh:	£ 105.27
	Electricity Saving:	£ 317.79
	Total Benefit:	£ 998.17
Payback Time:		7y 7m
Total Profit Over 20 years:		**£ 20,516.07 11.86 % per year (6.08% AER)**

Assumptions:

- Illustrative solar PV performance figures only. Figures are given in good faith but do not constitute "Financial Advice".
- Exact PV subsidy figures may depend on grants available at particular locations and other factors.

- Your property has an Energy Performance Certificate (EPC) rating of level D or better.
- Yearly PV output uses a factored degradation over time based on industry estimates.
- Tariffs shown presume installation after at the new FiT rates
- VAT is included (at 5% where appropriate) unless a new build is specified.
- Photovoltaic Panels will not be shaded (e.g. by Trees or Buildings) as shading affects PV output.
- Exact equipment costs are estimated based on retail prices in 2012 and will vary by installer/supplier.
- Installation costs are based on industry averages for installation type/size. Every install is different and you should obtain 3 uotes.
- Assuming that you pay 14.4p per unit and that around 35% of the solar electricity that you generate will be used in your home, having an export meter (you can change such assumptions above).

In order to qualify both the installer and the equipment must be certified under the Microgeneration Certification Scheme (MCS).

PV plant location(s) – To be located on the roof area.

CO_2 Emissions Reduction by PV

Option 1: Communal gas boilers + 5.232kWp PV BE GREEN stage

Building Services	BE CLEAN CO_2 Emissions (kg $CO_2/m^2/yr$)	BE GREEN Building CO_2 Emissions (kg $CO_2/m^2/yr$)
Heating + Hot Water	23.7	23.7
Auxiliary	0.00	0.00
Lighting	2.22	2.22
Energy generated by renewables	**-**	**-2.93**
Total regulated emissions	**25.93**	**22.99**

CO_2 Reductions after BE GREEN stage

Regulated Emissions	BE CLEAN Building CO_2 Emissions	BE GREEN Building CO_2 Emissions	% reduction in CO_2 Emissions
kgr of $CO_2/m^2/yr$	**25.93**	**22.99**	
Tonnes CO_2/ yr	**18.23**	**16.16**	**11.3%**

From the table above it can be seen that the overall CO_2 reduction due to energy efficiency is ***<u>11.3%</u>*** for the total emissions.

Option 2: Communal ASHP + 5.232kWp PV BE GREEN stage

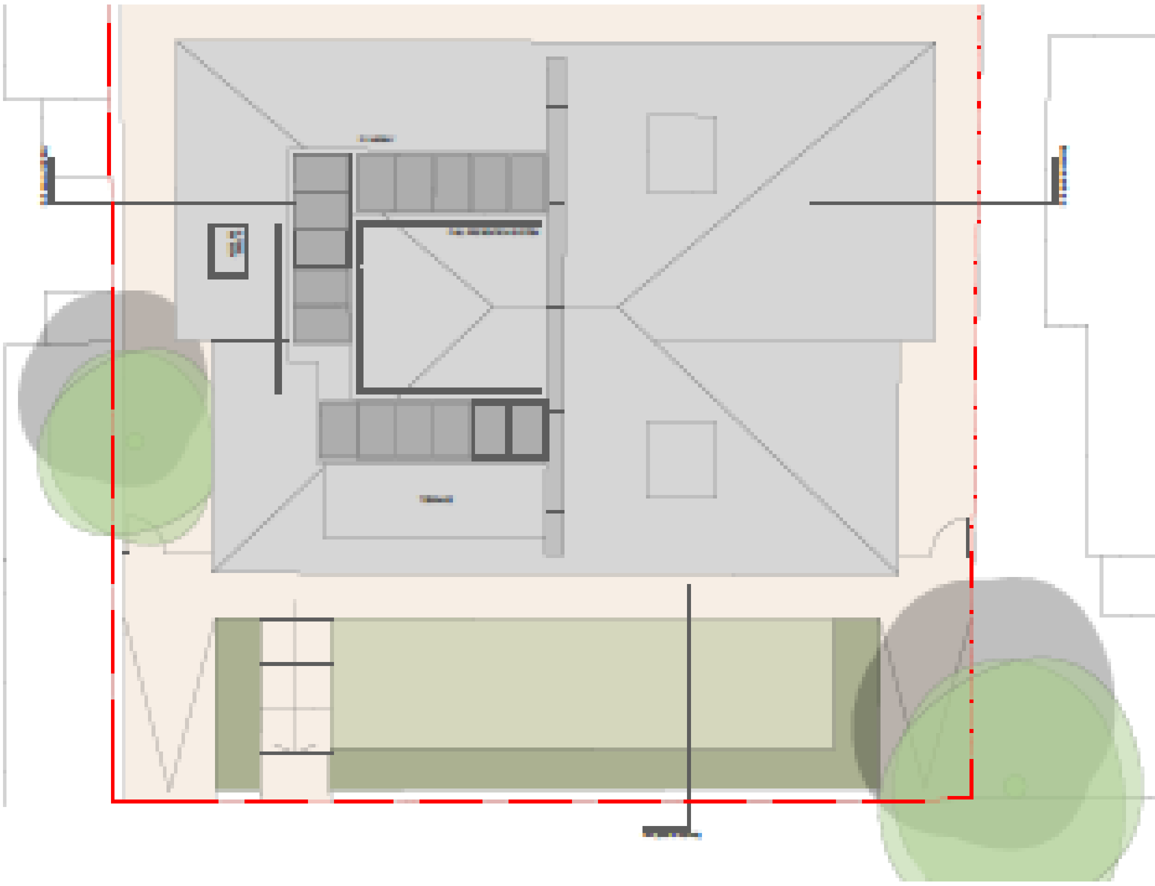
Building Services	BE CLEAN CO2 Emissions (kg $CO_2/m^2/yr$)	BE GREEN Building CO_2 Emissions (kg $CO_2/m^2/yr$)
Heating + Hot Water	18.17	18.17
Auxiliary	0.00	0.00
Lighting	2.22	2.22
Energy generated by renewables	**-**	**-2.93**
Total regulated emissions	**20.39**	**17.45**

CO_2 Reductions after BE GREEN stage

Regulated Emissions	BE CLEAN Building CO_2 Emissions	BE GREEN Building CO_2 Emissions	% reduction in CO_2 Emissions
kgr of $CO_2/m^2/yr$	20.39	17.45	
Tonnes CO_2/ yr	14.33	12.26	14.41%

From the table above it can be seen that the overall CO_2 reduction due to energy efficiency is ***14.41 %*** for the total emissions.

Note: The total area available for PVs is limited to 25.6m2. The development is located in the Conservation area and therefore the design ensures that the PV panels are not visible on the front elevation. An indicative roof plan is shown below.



10. Conclusion

Due to the site spatial limitations, location and the other issues identified previously in the report technologies such as Ground Source Heat Pump, Biomass, Solar Thermal, Hydroelectricity and Wind turbines are immediately unfeasible. The design has incorporated building fabric enhancement (above current building regs requirements) to increase the energy efficiency of the building.

The recommendation for the proposed development at **Clifford Pugh House, 5-7 Lancaster Grove, London, NW3** is that **Efficient Communal Air Source Heat Pumps should be progressed for the residential units. In addition, a total of 5.232kWp PV (which equals to 16 PV panels in total and approximately 25.6m^2 total required roof area) should be progressed for the whole development.** This is based on the following reasons:

1. PV plant location(s) – The plant would be located on the roof area. The PV panels are based on high output, high efficiency Sunpower 327 watts.
2. The strategy would provide an average of **74.50% CO_2 reduction from the Existing Building to the proposed converted and refurbished residential units. Therefore, the strategy meets BRUK-L1B 2013 requirements for the development.**
3. The development is located within a Conservation area. This has been taken into consideration and hence the proposed renewables (PVs) have been only placed on the part of the roof which is not visible from the street. Thus a total area of 25.6 m^2 has been allocated to the installation of PVs. The strategy would provide **an average 14.41% reduction of CO_2 emissions the energy demand via onsite renewable technology (PV) for the overall development. Hence, a relaxation for the 20% target is being requested.**
4. A separate BREEAM Domestic Refurbishment pre-assessment has been undertaken for the Refurbished residential units of the development. **The BREEAM pre-assessment demonstrates that a rating of "Excellent can be achieved for all the dwellings** [See the Appendix for the BREEAM pre-assessment report].
5. After the application of the Energy Hierarchy, the regulated carbon dioxide emissions are presented on the table below:

	Carbon Dioxide emissions (Tonnes CO_2 per annum)
	Regulated
Existing Building	48.11
After energy demand reduction	19.13
After CHP/ Communal Heating	14.33
After renewable energy	12.26

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

The chart below summarizes the regulated carbon dioxide savings from each stage of the Energy Hierarchy:

	Regulated Carbon Dioxide savings	
	(Tonnes CO_2 per annum)	**(%)**
Savings from energy demand reduction	28.92	60.23%
Savings from CHP/ Communal Heating	4.79	25.09%
Savings from Renewable energy	2.07	14.41%
Total Cumulative Savings	**35.78**	**74.50%**
Total Target Savings	**0.48**	**>1%**
Annual Surplus	**35.30**	

Table: Regulated carbon dioxide savings from each stage of the Energy Hierarchy

The key metrics currently envisaged for the development are listed below:

- **The carbon saving attributable to energy efficiency measures:** 60.23 %
- **The carbon saving attributable to clean measures:** 25.09 %
- **The carbon saving attributable to renewable energy technologies:** 14.41 %
- **The proposed development's overall improvement over the Existing building baseline:** 74.50 % - As can be seen from the table above, the development meets the 35% target.

11. Appendix

- ✓ Low & Zero Carbon Energy Systems
- ✓ Typical SAP checklist
- ✓ Block Compliance Sheet
- ✓ BREEAM pre-assessment

11.1. Low & Zero Carbon Energy Systems

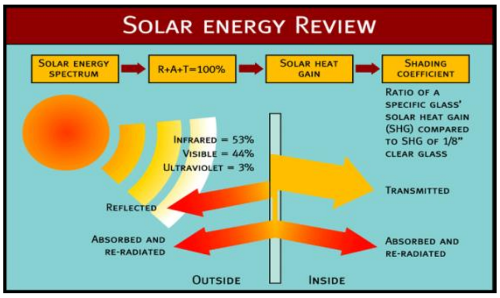
The following section is an overview of the LZC energy systems that are available and can be implemented to the building environment. Firstly, a brief description of the types of renewable energy (zero carbon energy) that can be harnessed with technology will be presented. In addition, the renewable 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 (Renewable) Energy Overview

Renewable energy is the energy that is grasped by the earth's abundant natural sources. Renewable energy can be harnessed with the appropriate use of technology to satisfy the human energy needs. Solar, wind, wave, tide and bio energy are termed as renewable. These renewable energy sources can be classified as 'active' or 'passive'. Active RES are the renewable sources which with the use of renewable energy systems technology (REST) can generate power and heat to satisfy the energy and heating demands of buildings. Passive RES are the renewable sources which with the use of static building elements can enhance the natural ventilation and the heating of a building.

- ✓ **Solar Energy**

Solar energy is the energy of sun light. The temperature of the Sun's surface reaches to a value of approximately 5,762K. The Earth's perimeter of 40,000 km results in an intersected sun power of 174,000TW. Attenuation by the atmosphere results in peak intensity at sea level of around 1kW/m2, giving a 24 hour annual average of 0.2kW/m2 and a 24 hour annual average power of 102,000 TW.



This commands the environment and maintains the life support system of Earth's ecosystem and all forms of renewable energy with the exception of geothermal energy. The solar energy reaching the earth's surface surpasses 10,000 times the current global energy demand.

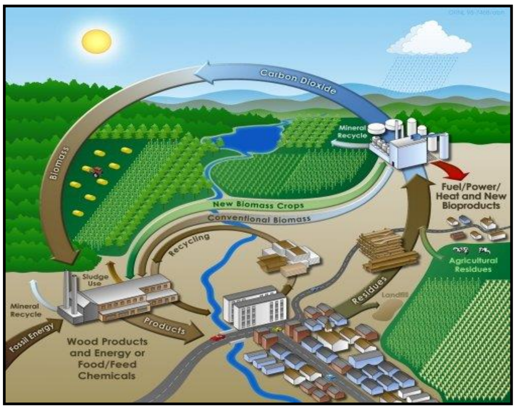
To be more specific in terms of harnessing solar energy we are interested with the irradiance. Irradiance is the energy of light incident on a solar collector. Irradiance is measured in energy per area, (W/m2). The solar irradiance received on the Earth's surface consists of three components, the beam irradiance, diffuse and ground reflected irradiance. The beam component is the irradiance that reaches the solar collector directly. The diffuse irradiance is formulated due to scattering and absorption in the earth's atmosphere. Finally, the ground reflected irradiance is formed due to the sunlight reflected by the earth's ground.

- ✓ **Wind Energy**

Wind energy is the energy found in the wind that is grasped by REST in order to generate power for human benefit. Wind turbines are the REST used to collect the wind resource and generate power. Today, wind turbines are used to generate electricity from the wind. There are two types of wind turbines, the horizontal axis turbine which is the most common one and the vertical axis turbine. The HAWT is the most efficient and cost effective. Most of the wind turbines used for electricity generation is of this type. Wind turbines can be found in many sizes and outputs, from small battery charging turbines (say a rotor diameter of 1 or 2 metres with an output of a few hundred Watts) to the largest machines used to supply electricity to the grid (Rotor diameters in excess of 70m and output powers of over two MW).

- ✓ **Bio-energy**

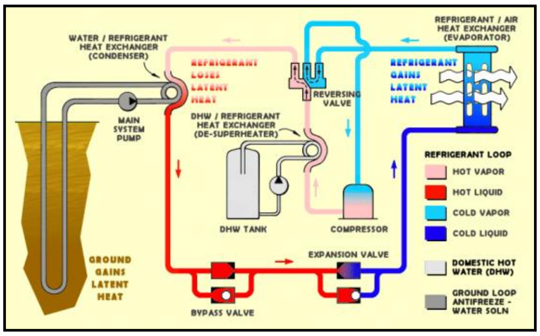
Bio-energy is the energy produced from biomass. Biomass is available from materials derived from biological sources. Biomass is any organic material which has stored sunlight in the form of chemical energy. As a fuel it may include wood, wood waste, straw, manure, sugar cane, and many other by products from a variety of agricultural processes. Energy from biomass is produced by burning organic matter.



Biomass is the solid form of 'bioenergy', but liquid fuels can also be generated from plant matter and this is referred to as 'biofuel'. Biomass is carbon-based so when used as fuel it also generates carbon emissions. However, the carbon that is released during combustion is equivalent to the amount that was absorbed during growth, and so the technology is carbon-neutral.

- ✓ **Geothermal Energy**

Geothermal energy is the heat from the Earth. It's clean and sustainable. Resources of geothermal energy range from the shallow ground to hot water and hot rock found a few miles beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma. Almost everywhere, the shallow ground or upper 10 feet of the Earth's surface maintains a nearly constant temperature between 10° and 16°C. Geothermal heat pumps can tap into this resource to heat and cool buildings. A geothermal heat pump system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger-a system of pipes buried in the shallow ground near the building. In the winter, the heat pump removes heat from the heat exchanger



and pumps it into the indoor air delivery system. In the summer, the process is reversed, and the heat pump moves heat from the indoor air into the heat exchanger. The heat removed from the indoor air during the summer can also be used to provide a free source of hot water.

11.2.1. Zero Carbon Technologies

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

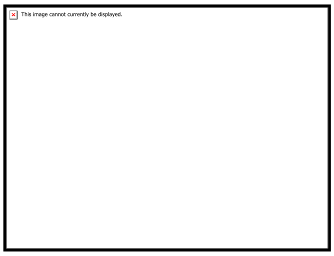
- Photovoltaics (PV)
- Solar Water Heating
- Wind Turbines
- Small scale Hydro Power
- Biomass Heating

11.2.1.1. **Photovoltaic Systems**

<u>Description of PV Systems</u>

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.

<u>Advantages</u>

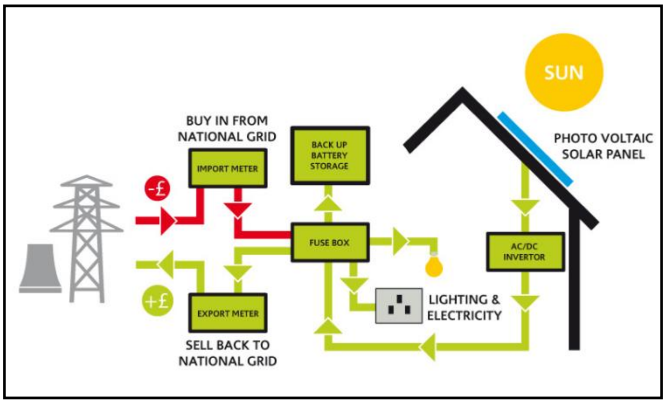
The PV systems are relatively simple, modular, and highly reliable due to the lack of moving parts. Moreover, PV systems do not produce any greenhouse gases, on the contrary they save approximately 325kg of CO_2 per year kWp they generate.

<u>Best Practice Design</u>

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 require 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. For an average domestic system, costs of a PV system can be around £4000 -£9000 per kWp installed, with most domestic systems usually between 1.5 and 2 kWp. 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.



Available Grants

The Feed - In - Tariffs have been introduced in order to give an incentive for PV generated electricity. The Feed-In-Tariffs scheme is based on the principle that the energy supplier pays generation tariff for every kWh the PV system generates and an export tariff for every kWh of electricity supplied back to the national grid.

Tariff level for new Solar PV installations after 1st August 2012 (pence/kWh). For non PV technologies there will be new rates as of October 2012

Technology	Scale	Standard generation tariff	Multi-installation tariff	Lower tariff if energy efficiency requirement not met
PV	≤4 kW (new build)	16.0	14.4	7.1
PV	≤4 kW (retrofit)	16.0	14.4	7.1
PV	>4-10 kW	14.5	13.05	7.1
PV	Stand alone system	7.1	N/A	N/A

Description of Solar Water Heating System

Solar water heating systems use solar energy to heat water. Depending on the type of solar collector used, the weather conditions, and the hot water demand, the temperature of the water heated can vary from tepid to nearly boiling. Most solar systems are meant to furnish 20 to 85% of the annual demand for hot water, the remainder being met by conventional heating sources, which either raise the temperature of the water further or provide hot water when the solar water heating system cannot meet demand.

11.2.1.2. 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. The average domestic system reduces CO_2 by 325 kg per year approximately and around £50 a year of hot water bills, when installed in a gas heated home.

Fuel Displaced	£ Saving per year	CO_2 saving per year kg
Gas	50	325
Electricity	80	635

Table 4

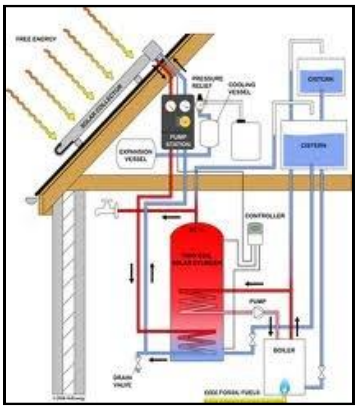
The savings presented on the previous table are approximate and are based on the hot water heating demand of a 3 bed semi-detached house.

Best Design Practice

For domestic systems a 3-4 m^2 of southeast to southwest facing roof receiving direct sunlight for the main part of the day is required. Also, more space will be needed if a water cylinder is required.

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

A typical installation cost for a domestic SHW system is £3000-£5000. 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.

Available Grants

In March 2011, the UK Government announced the details of their Renewable Heat Incentive (RHI). RHI is designed to provide financial support that encourages individuals, communities and businesses to switch from using fossil fuel for heating, to renewables such as wood fuel.

There will be two phases for domestic customers:

Phase 1 (available from July 2011) - "RHI Premium Payment"

This is called the "RHI Premium Payment" and will be worth around £15m and available to 25,000 householders in Great Britain who install from July 2011.

The exact amounts available to consumers are confirmed:

* Solar Thermal - £300/unit

These are one off payments; so not annual. DECC plan to publish details of the "Phase 2 RHI Payment" and how this will apply next year. Recipients of this payment will need to ensure that:

* They have a well-insulated property based on its energy performance certificate;
* They agree to give feedback on how the equipment performs.

Phase 2 (available from October 2012) – RHI tariffs

People in receipt of the Renewable Heat Premium Payments will be able to receive long term RHI tariff support once these tariffs are introduced, as will anybody who has installed an eligible technology since 15th July 2009.

These tariff payments will start alongside the Green Deal from October 2012 to allow a more whole-house approach to heat production and energy saving.

11.2.1.3. 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.

Available Grants

The Feed - In – Tariffs have been introduced in order to give an incentive for wind generated electricity. The Feed-In-Tariffs scheme is based on the principle that the energy supplier pays generation tariff for every kWh the wind system generates and an export tariff for every kWh of electricity supplied back to the national grid.

- Generation Tariff: 28.0 – 36.20 pence/kWh depending on installed rated output (up to 15KW)
- Export Tariff: 3.10pence/kWh
- Tariff period duration is 20 years

11.2.1.4. 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 – so a typical 5kW domestic scheme might cost £20-£25,000.

Unit costs drop for larger schemes. Maintenance costs vary but small scale hydro systems are very reliable.

Available Grants

The Feed - In – Tariffs have been introduced in order to give an incentive for hydroelectric generated electricity. The Feed-In-Tariffs scheme is based on the principle that the energy supplier pays generation tariff for every kWh the hydroelectric system generates and an export tariff for every kWh of electricity supplied back to the national grid.

- Generation Tariff: 20.90 pence/kWh depending on installed rated output (up to 15KW)
- Export Tariff: 3.10pence/kWh
- Tariff period duration is 20 years

11.2.1.5. 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.

Available Grants

In March 2011, the UK Government announced the details of their Renewable Heat Incentive (RHI). RHI is designed to provide financial support that encourages individuals, communities and businesses to switch from using fossil fuel for heating, to renewables such as wood fuel.

The RHI is in two phases:

Phase 1 (available from July 2011) - "RHI Premium Payment"

This is called the "RHI Premium Payment" and will be worth around £15m and available to 25,000 householders in Great Britain who install from July 2011.

The exact amounts available to consumers have yet to be confirmed. However the Department of Energy and Climate Change (DECC) have announced that the following amounts may be available:

* Biomass boilers - £950/unit (available only to off-gas installations)

These are one off payments; so not annual. DECC plan to publish details of the "Phase 2 RHI Payment" and how this will apply next year. Recipients of this payment will need to ensure that:

* They have a well-insulated property based on its energy performance certificate;
* They agree to give feedback on how the equipment performs.

Phase 2 (available from October 2012) – RHI tariffs

People in receipt of the Renewable Heat Premium Payments will be able to receive long term RHI tariff support once these tariffs are introduced, as will anybody who has installed an eligible technology since 15th July 2009.

These tariff payments will start alongside the Green Deal from October 2012 to allow a more whole-house approach to heat production and energy saving.

11.2.1.6. **Low Carbon Technologies**

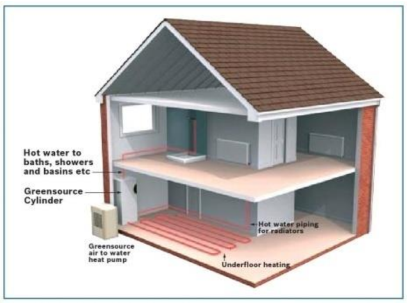
In this section the low carbon technologies are described.

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

11.2.1.7. **Air Source Heat Pumps (ASHP)**

<u>Description of Air Source Heat Pumps</u>

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.



<u>Advantages</u>

- 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

<u>Costs & Savings</u>

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.

<u>Available Grants</u>

In March 2011, the UK Government announced the details of their Renewable Heat Incentive (RHI).

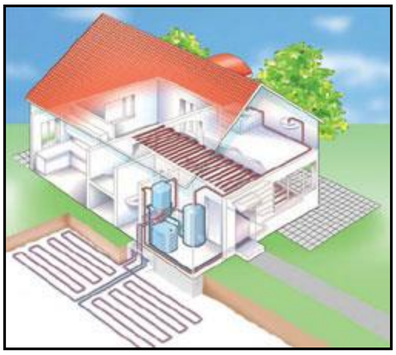
RHI is designed to provide financial support that encourages individuals, communities and businesses to switch from using fossil fuel for heating, to renewables such as wood fuel.

The RHI is in two phases:

Phase 1 (available from July 2011) - "RHI Premium Payment"
This is called the "RHI Premium Payment" and will be worth around £15m and available to 25,000 householders in Great Britain who install from July 2011.

The exact amounts available to consumers are confirmed:
* Air Source Heat Pumps - £850/unit (available only for off-gas installations)

These are one off payments; so not annual. DECC plan to publish details of the "Phase 2 RHI Payment" and how this will apply next year. Recipients of this payment will need to ensure that:
* They have a well-insulated property based on its energy performance certificate;
* They agree to give feedback on how the equipment performs.



Phase 2 (available from October 2012) – RHI tariffs
People in receipt of the Renewable Heat Premium Payments will be able to receive long term RHI tariff support once these tariffs are introduced, as will anybody who has installed an eligible technology since 15th July 2009.

Whilst Air source heat pumps will be eligible for the Renewable Premium Payment, a decision on whether or not they'll be included in the tariff payments will be based upon consumer feedback on the performance of the technologies. This should be clarified towards the end of 2011.

These tariff payments will start alongside the Green Deal from October 2012 to allow a more whole-house approach to heat production and energy saving.

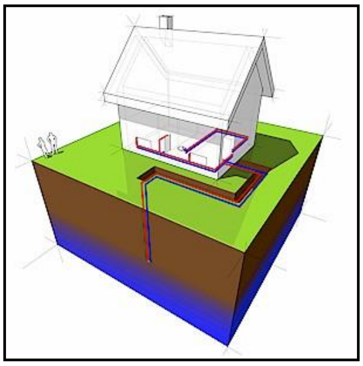
11.2.1.8. Ground Source Heat Pumps (GSHP)

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 domestic 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.

Available Grants

In March 2011, the UK Government announced the details of their Renewable Heat Incentive (RHI). RHI is designed to provide financial support that encourages individuals, communities and businesses to switch from using fossil fuel for heating, to renewables such as wood fuel.

There will be two phases for domestic customers:

Phase 1 (available from July 2011) - "RHI Premium Payment"
This is called the "RHI Premium Payment" and will be worth around £15m and available to 25,000 householders in Great Britain who install from July 2011.
The exact amounts available to consumers are confirmed:
*Ground Source Heat Pumps - £1,250/unit (available for off-gas installations only)

These are one off payments; so not annual. DECC plan to publish details of the "Phase 2 RHI Payment" and how this will apply next year. Recipients of this payment will need to ensure that:
* They have a well-insulated property based on its energy performance certificate;
* They agree to give feedback on how the equipment performs.

Phase 2 (available from October 2012) – RHI tariffs
People in receipt of the Renewable Heat Premium Payments will be able to receive long term RHI tariff support once these tariffs are introduced, as will anybody who has installed an eligible technology since 15th July 2009.

These tariff payments will start alongside the Green Deal from October 2012 to allow a more whole-house approach to heat production and energy saving

11.2.1.9. 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 domestic hot water, or for space heating.

Advantages
CHP can significantly reduce primary energy consumption, and can therefore have a major impact on CO_2 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 CO_2 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.

Available Grants

The Feed - In – Tariffs have been introduced in order to give an incentive for micro CHP generated electricity. The Feed-In-Tariffs scheme is based on the principle that the energy supplier pays generation tariff for every kWh the micro CHP system generates and an export tariff for every kWh of electricity supplied back to the national grid.

- Generation Tariff: 10.50 pence/kWh depending on installed rated output (up to 2KW)
- Export Tariff: 3.10pence/kWh
- Tariff period duration is 10 years

11.2.1.10. **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

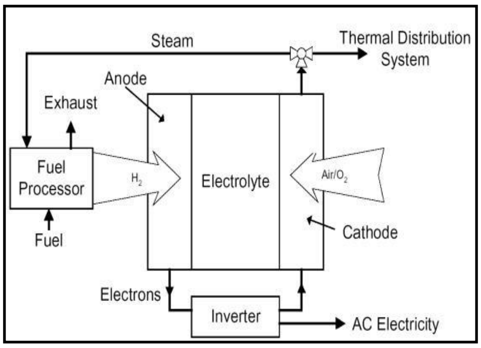
Even better, since fuel cells create electricity chemically, rather than by combustion, they are not subject to the thermodynamic laws that limit a conventional power plant. Therefore, fuel cells are more efficient in extracting energy from a fuel. Waste heat from some cells can also be harnessed, boosting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

11.2.1.11. Be Green – Renewable Technology

In this section the viable renewable energy technologies that will reduce the development's CO_2 emissions further by 20% are examined. Incorporating green design measures will significantly reduce the onsite energy consumption and the CO^2 emissions of the building. The 'London Plan' states that a further CO^2 reduction of 20% must be achieved by the installation of renewable technologies. 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:

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

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

- Wind Turbines
- Biomass Boilers
- Micro CHP
- Hydrogen Fuel Cells
- Small Scale Hydro Power
- Grd. Source Heat Pump (GSHP)

Wind Turbines

Wind turbines are not feasible for the development since it does not meet the criteria mentioned above. 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. The yearly average wind speed is quite low at 10 meters above ground.

4.9	5.3	5.6
4.8	4.8	5
4.9	4.8	4.9

Wind speed at 25m above ground level (m/s)

5.7	6	6.3
5.6	5.6	5.8
5.7	5.6	5.7

Wind speed at 45m above ground level (m/s)

6.2	6.5	6.7
6.1	6.2	6.3
6.1	6.1	6.2

Squares surrounding the central square correspond to wind speeds for surrounding grid squares.

What does this mean?

Power generated is related to wind-speed by a cubic ratio. That means if you halve the wind-speed, the power goes down by a factor of 8 (which is 2 x 2 x 2). A quarter of the wind-speed gives you a 64th of the power (4 x 4 x 4).

As a rough guide, if your turbine is rated at producing 1KW at 12m/s then it will produce 125W at 6m/s and 15W at 3m/s

Please Note! Bear in mind that the NOABL wind-speed dataset used here is a model of wind-speeds across the country, assuming **completely flat terrain**. It isn't a database of measured wind-speeds. Other factors such as hills, houses, trees and other obstructions in your vicinity need to be considered as well as they can have a significant effect.

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

The central square highlighted in yellow demonstrates the average wind speed in m/s for the site. Squares surrounding the central square correspond to wind speeds for surrounding grid squares.
From the above table it is shown that the average wind speed on the development according to **NOABL database was estimated at 4.8m/s at 10m high above ground and 5.6m/s at 25m above ground.**

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 neighboring Commercial units & residential properties and trees.

- In addition, the low frequency noise generated by wind turbines might cause inconvenience to the neighboring 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 neighborhood committee interest regarding its aesthetics and acoustic issues).

Biomass Boilers

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.
- The whole of London Borough of Hillington is in a smoke control zone.

Hydrogen Fuel Cells

No commercial units viable yet - As a result this solution will not be assessed any further.
The BlueGen product is a ceramic fuel cell and has recently entered the UK market this year.
Using ceramic fuel cells, BlueGen® electrochemically converts natural gas into electricity at up to 60 per cent electrical efficiency. Electricity is consumed locally, with unused power being exported to the grid. When the integrated heat recovery system is connected, the waste heat from BlueGen can be used to produce hot water - which improves the total efficiency to approximately 85 per cent.

Small Scale Hydro

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.

Ground Source Heat Pump (GSHP)

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.

CHP & Micro CHP

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 (Baxi Ecogen was made available in 2009) 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 other issues surrounding the fact that around 50% of electricity generated in domestic properties is surplus, 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.

Regulations Compliance Report

Approved Document L1A, 2013 Edition, England assessed by Stroma FSAP 2012 program, Version: 1.0.1.14
Printed on 26 November 2014 at 14:31:25

Project Information:

Assessed By: ()
Building Type: Flat

Dwelling Details:

NEW DWELLING DESIGN STAGE
Total Floor Area: 56m²

Site Reference : Lancaster Grove
Plot Reference: Flat 1 - Proposed

Address : 5-7 Lancaster Grove, London, NW3

Client Details:

Name:
Address :

This report covers items included within the SAP calculations.
It is not a complete report of regulations compliance.

1a TER and DER

Fuel for main heating system: Electricity (c)
Fuel factor: 1.47 (electricity (c))

Target Carbon Dioxide Emission Rate (TER)	28.61 kg/m²	
Dwelling Carbon Dioxide Emission Rate (DER)	16.61 kg/m²	OK

1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)	50.36 kWh/m²	
Dwelling Fabric Energy Efficiency (DFEE)	79.70 kWh/m²	
		Fail

Excess energy = 29.34 kg/m² (58.3 %)

2 Fabric U-values

Element	Average	Highest	
External wall	0.25 (max. 0.30)	0.25 (max. 0.70)	OK
Floor	0.20 (max. 0.25)	0.20 (max. 0.70)	OK
Roof	(no roof)		
Openings	1.45 (max. 2.00)	1.70 (max. 3.30)	OK

2a Thermal bridging

Thermal bridging calculated using user-specified y-value of 0.15

3 Air permeability

Air permeability at 50 pascals	15.00 (As in this dwelling)	OK

4 Heating efficiency

Main Heating system:	Community heating schemes - Heat pump
Secondary heating system:	None

5 Cylinder insulation

Hot water Storage:	Nominal cylinder loss: 1.32 kWh/day Permitted by DBSCG: 1.85 kWh/day	
Primary pipework insulated:	Yes	OK

6 Controls

Space heating controls	Charging system linked to use of community heating, programmer and TRVs	OK
Hot water controls:	Cylinderstat	OK

Regulations Compliance Report

7 Low energy lights

Percentage of fixed lights with low-energy fittings	100.0%	
Minimum	75.0%	**OK**

8 Mechanical ventilation

Not applicable

9 Summertime temperature

Overheating risk (Thames valley):	Slight	**OK**
Based on:		
Overshading:	Average or unknown	
Windows facing: South	4.94m²,	
Windows facing: North	4.94m²,	
Ventilation rate:	3.00	
Blinds/curtains:	None	
	Closed 100% of daylight hours	

10 Key features

Community heating, heat from electric heat pump
Photovoltaic array

Block Compliance WorkSheet: refurbished flats

User Details

Assessor Name:
Stroma Number:
Software Name: Stroma FSAP
Software Version: Version: 1.0.1.14

Calculation Details

Dwelling	DER	TER	DFEE	TFEE	TFA
Flat 1 - Proposed	16.61	28.61	79.7	50.4	56
Flat 2 - Proposed	16.61	28.61	79.7	50.4	56
Flat 3 - Proposed	17.51	28.53	86.6	60.6	82.5
Flat 4 - Proposed	17.51	28.53	86.6	60.6	82.5
Flat 5 - Proposed	16.99	27.68	83.2	57.4	82.5
Flat 6 - Proposed	16.99	27.68	83.2	57.4	82.5
Flat 7 - Proposed	17.42	25.8	86.9	60.6	130.5
Flat 8 - Proposed	17.42	25.8	86.9	60.6	130.5

Calculation Summary

Total Floor Area	703.00
Average TER	27.33
Average DER	17.21
Average DFEE	84.81
Average TFEE	58.22
Compliance % Improvement DER|TER % Improvement DFEE|TFEE	Fail N/A N/A

Conversion and refurbishment at Clifford Pugh House, 5-7 Lancaster Grove, London, NW3
Building Regulation Part L1B Compliance

Summary

Part L1B 2013 compliance requires calculations to show improvements in the CO_2 emissions between the Existing building, using Part L1B document – standards for new thermal elements reference values and the proposed conversion and refurbishment to 8No. residential units, using declared U values, with improvements made where necessary.

Software used – Govt approved FSAP 2012 Stroma

Extract from L1B 2011:
- 4.11: Material changes of use (see regulation 5 of the Building Regulations) covered by this document are where, after the change:
a) the building is used as a dwelling, where previously it was not;
b) the building contains a flat, where previously it did not; or
c) the building, which contains at least one dwelling, contains a greater or lesser number of dwellings than it did previously.

BRUKL Calculations

1. The calculations for the **existing building** gave the following results:

TER = 13.96 kgC02/m2.annum

BER = ***68.42*** kgC02/m2.annum

And

2. The calculations for the **proposed converted and refurbished residential units** gave the following results:

TER = 27.33 kgC02/m2.annum

BER = ***17.21*** kgC02/m2.annum

Improvements

The Improvements to the converted and refurbished dwellings include the following to the thermal elements and services:

1. Upgraded External Walls U value to be 0.25 w/m2k or better.
2. Upgraded Roof U value to be 0.16 w/m2k or better.
3. Upgraded Floor U value to be 0.2 w/m2k or better.
4. 100% Energy efficient Lighting
5. New Communal ASHP (300% efficiency)

Conclusion

The above results show a ***74.8%*** improvement (reduction) in CO_2 emissions from the **existing building** to the **proposed conversion and refurbishment** and therefore meets Building Regulations Part L1B 2013 criteria.

A.M. Wing-King
MSc, CEng, MEI, NDEA, OCDEA

25.11. 2014

elmhurst accredited energy assessor

BREEAM Domestic Refurbishment 2012 Pre-Assessment Estimator v0.6: Results Summary

BREEAM®

Building name	Clifford Pugh House, 5-7 Lancaster Grove
Indicative Building Score	72.77%
Indicative Building Rating	BREEAM Excellent

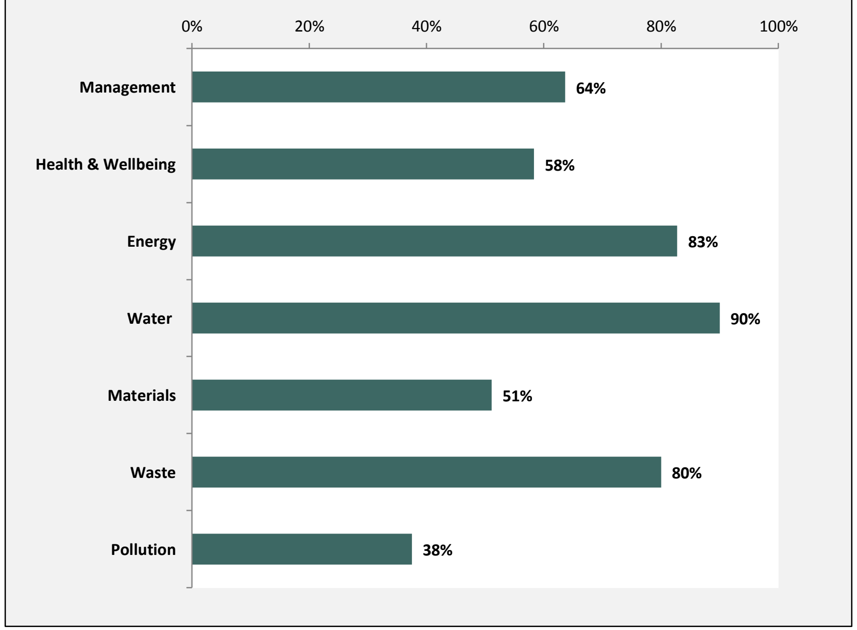
This assessment and indicative BREEAM rating is not a formal certified BREEAM assessment or rating and must not be communicated as such. The score presented is indicative of a dwelling's potential performance and is based on a simplified pre-formal BREEAM assessment and unverified commitments given at an early stage in the design process.

	Issue	Credits Available	Indicative Credits Achieved	Weighting	Section Score
Management	Man 01	3	3	12%	7.64%
	Man 02	2	1		
	Man 03	1	1		
	Man 04	2	0		
	Man 05	1	1		
	Man 06	2	1		
Health and Wellbeing	Hea 01	2	2	17%	9.92%
	Hea 02	4	2		
	Hea 03	1	0		
	Hea 04	2	1		
	Hea 05	2	1		
	Hea 06	1	1		
Energy	Ene 01	6	4	43%	35.59%
	Ene 02	4	3		
	Ene 03	7	7		
	Ene 04	2	0		
	Ene 05	2	2		
	Ene 06	1	1		
	Ene 07	2	2		
	Ene 08	2	2		
	Ene 09	2	2		
	Ene 10	1	1		
Water	Wat 01	3	2.5	11%	9.90%
	Wat 02	1	1		
	Wat 03	1	1		
Materials	Mat 01	25	15	8%	4.09%
	Mat 02	12	0		
	Mat 03	8	8		
Waste	Was 01	2	1	3%	2.40%
	Was 02	3	3		
Pollution	Pol 01	3	0	6%	2.25%
	Pol 02	3	1		
	Pol 02	2	2		
Innovation		10	1	N/A	1.00%

Minimum Standards

	Pass	Good	Very Good	Excellent	Outstanding
Ene 02	✓	✓	✓	✓	✗
Wat 01	✓	✓	✓	✓	✗
Hea 05	✓	✓	✓	✓	✓
Hea 06	✓	✓	✓	✓	✓
Pol 03	✓	✓	✓	✓	✓
Mat 02	✓	✓	✓	✓	✓

Percentage of Category Score Attained



BREEAM Domestic Refurbishment 2012 Pre-Assessment Estimator v0.7

BREEAM

This assessment and indicative BREEAM rating is not a formal certified BREEAM assessment or rating and must not be communicated as such. The score presented is indicative of a dwelling's potential performance and is based on a simplified pre-formal BREEAM assessment and unverified commitments given at an early stage in the design process.

Building name	Clifford Pugh House, 5-7 Lancaster Grove
Indicative building score (%)	72.77%
Indicative BREEAM rating	BREEAM Excellent

Management | Health & Wellbeing | Energy | Water | Materials | Waste | Pollution

Minimum Standards	Pass	Good	Very Good	Excellent	Outstanding
Ene 02	✓	✓	✓	✓	✗
Wat 01	✓	✓	✓	✓	✗
Hea 05	✓	✓	✓	✓	✓
Hea 06	✓	✓	✓	✓	✓
Pol 03	✓	✓	✓	✓	✓
Mat 02	✓	✓	✓	✓	✓

INNOVATION

Section Weighting: 10% Indicative Section Score: 1.00%

Comments

MANAGEMENT

Section Weighting: 12% Indicative Section Score: 7.64%

Man 01 Home Users Guide

No. of BREEAM credits available	3	Available contribution to overall score	3.27%
No. of BREEAM innovation credits	0	Minimum Standards applicable:	No

Assessment Criteria

Where a Home Users Guide be provided to all dwellings, covering all issues set out in the 'Users Guide Contents list', three credits may be awarded

Indicative Credits: 3

Comments

3No credits will be achieved since a Home User Guide will be produced and will cover all listed items in the User Guide Contents List.

Man 02 Responsible Construction Practices

No. of BREEAM credits available	2	Available contribution to overall score:	2.18%
No. of BREEAM innovation credits	1	Minimum Standards	No

Assessment Criteria

Where a compliant considerate construction scheme will be used, credits are awarded depending the score achieved as outlined below:

Indicative Credits: 1

Large Scale - project with more than 5 units

	One Credit	Two Credits
Considerate Constructors Scheme	Score of 25-34 with a score of 5 in each section	Score of 35-39 with a score of 7 in each section
Alternative Compliant Scheme	Compliance	Beyond Compliance

Small Scale - project with 5 units or fewer

	One Credit	Two Credits
Considerate Constructors Scheme	Score of 25-34 with a score of 5 in each section	Score of 35-39 with a score of 7 in each section
Alternative Compliant Scheme	Compliance	Beyond Compliance
Checklist A-3	50% of the optional items	80% of the optional items

Exemplary Credit

Considerate Constructors Scheme	Score of 40 or more with a score of 7 in each section
Alternative Compliant Scheme	Exemplary Level Compliance
Checklist A-3*	All Items (Optional & Mandatory)

* Small Scale Project Only

Indicative Innovation Credits Achieved: Please Select

Comments

1No Credit will be awarded. It is assumed that the principal contractor will use the Considerate Constructors Scheme (CCS) with a score of 25-34 or address 50% of the items in Checklist A-4.

Man 03 Construction Site Impacts

No. of BREEAM credits available	1	Available contribution to overall score	1.09%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where evidence demonstrate that site impacts will be monitored, as detailed below:

Indicative Credits: 1

	One Credit
Large Scale	Where there is evidence to demonstrate that **2 or more** of the sections in **Checklist A-4** are completed
Small Scale	Where there is evidence to demonstrate that **2 or more** of the sections in **Checklist A-5** are completed

Sections of Checklist	
Large Scale - Checklist A-4	**Small Scale - Checklist A-5**
Monitor, report and set targets for CO2 production of energy use arising from site activities	Set objectives for reducing CO2 production from energy use arising from site activities
Monitor, report and set targets for water consumption arising from site activities	Set objectives for reducing water use arising from site activities
A main contractor with an environmental materials policy	Main contractor environmental materials statement
A main contractor that operates an Environmental Management System	80% of site timber is reclaimed, re-used or responsibly sourced
80% of site timber is reclaimed, re-used or responsibly sourced	

Same definition of small and large scale as in Man 02

Comments

1No Credit will be achieved since the main contractor will (i) set objectives for reducing CO2 production from energy use arising from site activities (ii) set objectives for reducing water use arising from site activities (iii) provide environmental materials statement.

Man 04 Security

No. of BREEAM credits available	2	Available contribution to overall score:	2.18%
No. of BREEAM innovation credits	0	Minimum Standards applicable:	No

Assessment Criteria

Where the following requirements will be met:

Indicative Credits: 0

One Credit Secure windows and doors	External doors and accessible windows meet minimum standards and appropriately certified
Two Credits Secured by design	Principles and guidance of Secured by Design Section 2 are complied with A suitably qualified security consultant is consulted at the design stage and their recommendations are incorporated into the refurbishment

Comments

Credit not sought

Man 05 Protection and Enhancement of Ecological Features

No. of BREEAM credits available	1	Available contribution to overall score:	1.09%
No. of BREEAM innovation credits	1	Minimum Standards applicable:	No

Assessment Criteria

Where the following requirements will be met:

Indicative Credits: 1

One Credit Protecting Ecological Features	Site survey carried out to determine presence of ecological features Statutory Nature Conservation Organisation notified of protected species Features of ecological value protected during refurbishment works
Exemplary Credit **Ecological enhancement**	A suitably qualified ecologist recommends features to enhance ecology of the site adopts all general ecological recommendations adopts 30% of additional recommendations

Indicative Innovation Credits Achieved: 0

Comments

1No credit will be achieved since (i) a site survey and strategic report will be undertaken by a suitably qualified ecologist, (ii) Features of ecological value will be protected during refurbishment works (iii) Statutory nature conservation organisations will be notified of protected species.

Man 06 Project Management

No. of BREEAM credits available	2	Available contribution to overall score	2.18%
No. of BREEAM innovation credits	2	Minimum Standards applicable	No

Assessment Criteria

Where the following requirements will be met:

Indicative Credits: 1

One Credit Project Roles and Responsibilities	Where all of the project team are involved in the project decision making **Small Scale** - the project manager assigns individual and shared responsibilities amongst the project team including all trades on site **Large Scale** - the project manager assigns individual and shared responsibilities across the following key design and refurbishment stages: i. Planning and Building control notification ii. Design iii. Refurbishment iv. Commissioning and handover v. Occupation

Small Scale projects: five units or fewer and less than £100k **Large Scale projects: more than five units and more than £100k**

One Credit Handover and Aftercare	Handover meeting arranged 2 or more of the following committed to: - A site inspection within 3 months of occupation - Conduct post occupancy interviews with building occupants or a survey via phone or posted information within 3 months of occupation - Longer term after care e.g. a helpline, nominated individual or other appropriate system to support building users for at least the first 12 months of occupation

Exemplary Credits

Indicative Innovation Credits Achieved: 1

One Exemplary Credit Early Design Input	Where A BREEAM Accredited Professional has been appointed to oversee key stages within the project. OR Where a BREEAM Domestic Refurbishment Assessor has been appointed at an early stage of the project, prior to the production of a refurbishment specification
One Exemplary Credit Thermographic Surveying and Airtightness Testing	Where Thermographic surveying and Airtightness testing have been carried out at both pre and post refurbishment stages Where an improved air tightness target has been set at design stage and testing demonstrates that this has been achieved post refurbishment

Comments

For the 1st credit, (i) all of the project team will be involved in the project decision making (ii) the project manager will assign individual and shared reponsibilities amongst the project team including all trades on site. The 2nd credit can be achieved since this pre-assessmnet has been carried out from an appointed BREEAM Domestic Refurbishment Assessor at an early stage.

HEALTH & WELLBEING

Section Weighting: 17% — Indicative Section Score 9.92%

Hea 01 Daylighting

No. of BREEAM credits available	2	Available contribution to overall score	2.83%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where the refurbishment results in a neutral impact on daylighting or where minimum daylighting standards are met, up to two credits may be awarded as follows:

Indicative Credits: 2

For Existing Dwellings and Change of Use Projects

First Credit Maintaining Good Daylighting	The refurbishment results in a neutral impact on the dwellings daylighting levels in the kitchen, living room, dining room and study

Where the property is being extended

First Credit Maintaining Good Daylighting	New spaces achieve minimum daylighting levels
	The extension does not significantly reduce daylighting levels in the kitchen, living room, dining room or study of neighbouring properties

For All Properties

Second Credit Minimum Daylighting	The dwelling achieves minimum daylighting levels in the kitchen, living room, dining room and study

Comments

It is anticipated that the conversion/ refurbishment will meet the required minimum daylight factor levels. It is envisaged that daylight calculations will be undertaken during the detail design stage.

Hea 02 Sound Insulation

No. of BREEAM credits available	4	Available contribution to overall score	5.67%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

To ensure the provision of acceptable sound insulation standards and so minimise the likelihood of noise complaints.

Indicative Credits: 2

Properties where sound testing has been carried out:

Up to Four Credits	Four credits awarded according to the improvement over building regulations. See table in additional information in Technical Manual

Properties where sound testing is not feasible and not required by the appointed Building Control body

Two Credits	Where existing separating walls and floors are designed to meet the requirements of Building Regulations with compliant construction details
Up to Four Credits	Where a Suitably Qualified Acoustician (SQA) provides recommendations for the specification of all existing separating walls and floors
	SQA confirms in their professional opinion that they have the potential to meet or exceed the sound insulation credit requirements
	Where these recommendations are implemented
	See table in additional information in Technical Manual

Historic Buildings

Up to Four Credits	Where the dwelling is a Historic Building and sound testing results demonstrate existing separating walls and floor meet the Historic Building credit requirements
	See table in additional information in Technical Manual
	Where sound testing is not feasible and not required by the appointed Building Control body meeting criteria 2 and 3 using Table 12
	Properties where sound testing has been carried out, credits awarded according to the improvement over building regulations. See table in additional information in Technical Manual
	Where the dwelling is a detached property
	Where the dwelling is a propertywith separating walls or floors only between non habitable rooms OR Testing not required by building control body

Detached Properties

Four Credits	By Default

Properties with separating walls or floors only between non habitable rooms OR Testing not required by building control body

Four Credits	By Default

Comments

2No credits will be achieved if an accoustics consultant is on board and produces a noise assessment confirming Part E comliance. In the detailed stages of the project an assessment will be made of the expected reduction in internal noise levels as a result of the refurbishment.

Hea 03 Volatile Organic Compounds

No. of BREEAM credits available	1	Available contribution to overall score	1.42%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where the refurbishment avoids the use of VOCs with new products meeting the following requirements:

Indicative Credits: 0

One Credit Avoiding the use of VOCs	Where all decorative paints and varnishes used in the refurbishment have met the requirement listed in table 5.4 in the Technical Manual
	Where at least five of the eight remaining product categories listed in table 5.4 have met the testing requirements and emission levels for Volatile Organic Compound (VOC) emissions against the relevant standards identified within table 5.4 in the Technical Manual
	Where five or less products are specified within the refurbishment, all must meet the requirements in order to achieve this credit.

Comments

Credits not sought

Hea 04 Inclusive Design

No. of BREEAM credits available	2	Available contribution to overall score	2.83%
No. of BREEAM innovation credits	1	Minimum Standards applicable	No

Assessment Criteria

Where an access statement has been carried out using Checklist A-8 of the Technical Manual to optimise the accessibility of the home as follows:

Indicative Credits: 1

Checklist A-8 of the Technical Manual	
Section 1	Section 2

One Credit Minimum Accessibility	Completed with Evidence	
Two Credits Advanced Accessibility	Completed with Evidence	Completed with Evidence

Exemplary Performance

One Credit	Where an access expert suitably qualified member of the design team has completed sections 1, 2 and 3 of Checklist A-8, access statement template with evidence provided of the measures implemented in the refurbishment	⇨	**Indicative Innovation Credits Achieved** Please Select

Comments

An Access statement will be produced and checklist A-8 of the BREEAM technical manual will be completed by a member of the design team.

Hea 05 Ventilation

No. of BREEAM credits available	2		Available contribution to overall score	2.83%
No. of BREEAM innovation credits	0		Minimum Standards applicable	Yes

Assessment Criteria

Where the dwelling meets the following ventilation requirements:

Indicative Credits: 1

One Credit Minimum Ventilation Requirements	A minimum level of background ventilation is provided (with trickle ventilators or other means of ventilation) for all habitable rooms, kitchens, utility rooms and bathrooms compliant with section 7, Building Regulations Approved Document Part F, 2010
	A minimum level of extract ventilation is provided in all wet rooms (e.g. kitchen, utility and bath-rooms), compliant with section 5, Building Regulations Approved Document Part F 2010.
	A minimum level of purge ventilation is provided in all habitable rooms and wet rooms, compliant with section 7, Building Regulations Approved Document Part F, 2010.
	It is an historic building and meets historic building requirements in CN4 of the technical manual
Two Credits Advanced Requirements	Ventilation is provided for the dwelling that meets the requirements of Section 5 of Building Regulations Part F in full
	Where the building is a historic building and meets the requirements for Historic Buildings in compliance note 4 of the technical manual

Comments

It is assumed that a minimum level of background ventilation will be provided (with trickle ventilators or other means of ventilation) for all habitable rooms, kitchens and bathrooms compliant with section 7, Building Regulations Approved Document Part F, 2010. Also, it is assumed that a minimum level of extract ventilation will be provided in all wet rooms (e.g. kitchen, utility and bath-rooms), compliant with section 5, Building Regulations Approved Document Part F 2010. It is assumed that.a minimum level of purge ventilation is provided in all habitable rooms and wet rooms, compliant with section 7,Part F,

Hea 06 Safety

No. of BREEAM credits available	1		Available contribution to overall score	1.42%
No. of BREEAM innovation credits	0		Minimum Standards applicable	Yes

Assessment Criteria

Where a fire and carbon monoxide (CO) detection and alarm system is specified as follows:

Indicative Credits: 1

One Credit Fire and Carbon Monoxide (CO) Detection and Alarm Systems	Where a compliant fire detection and fire alarm system is provided
	Carbon Monoxide detector installed if dwelling is supplied with mains gas or other fossil fuel
	Mains supplied fire detection and alarm system if project involves re-wiring*
	Battery operated fire detection and alarm system if no re-wiring* is to take place

*** see CN9 in Hea 06 for the definition of re-wiring**

Comments

Fire detectors, alarm system and Carbon Monoxide Detectors will be installed. These will be mains supplied if the project involves rewiring. Battery operated if not.

ENERGY

Section Weighting: 43% **Indicative Section Score 35.59%**

Ene 01 Improvement in Energy Efficiency Rating

No. of BREEAM credits available	6		Available contribution to overall score	8.90%
No. of BREEAM innovation credits	0		Minimum Standards applicable	No

Assessment Criteria

Where the following targets are met for the improvement in Energy Efficiency Rating achieved as a result of refurbishment:

Indicative Credits: 4

Improvement in EER	Credits
≥ 5	0.5
≥ 9	1
≥ 13	1.5
≥ 17	2
≥ 21	2.5
≥ 26	3
≥ 31	3.5
≥ 36	4
≥ 42	4.5
≥ 48	5
≥ 54	5.5
≥ 60	6

Comments

Syntegra Consulting Ltd has undertaken the pre refurbishment SAP calculations as designed post refurbishment SAP calculations. The EER improvement is 38 and therefore 4No credit can be achieved.

Ene 02 Energy Efficiency Rating Post Refurbishment

No. of BREEAM credits available	4		Available contribution to overall score	5.93%
No. of BREEAM innovation credits	2		Minimum Standards applicable	Yes

Assessment Criteria

Where the following Energy Efficiency Rating benchmarks will be met as a result of refurbishment:

Indicative Credits: 3

EER post refurbishment	Credits	Minimum requirements
≥50	0.5	'Pass' level EER of 50
≥55	1	'Good' level EER of 58
≥60	1.5	
≥65	2	'Very Good level' EER of 65
≥70	2.5	'Excellent' level EER of 70
≥75	3	
≥80	3.5	'Outstanding' level EER of 81
≥85	4	

Exemplary	Credits
≥90	1
≥100	2

Indicative Innovation Credits Achieved: Please Select

Comments

The EER for post refurbishment is 77. Therefore, 3No credits are achieved.

Ene 03 Primary energy demand

No. of BREEAM credits available	7	Available contribution to overall score	10.38%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where the following Primary Energy Demand benchmarks will be met as a result of refurbishment:

Indicative Credits: 7

Primary Energy Demand Post Refurbishment ($kWh/m^2/year$)	Credits
≤ 400	0.5
≤ 370	1
≤ 340	1.5
≤ 320	2
≤ 300	2.5
≤ 280	3
≤ 260	3.5
≤ 240	4
≤ 220	4.5
≤ 200	5
≤ 180	5.5
≤ 160	6
≤ 140	6.5
≤ 120	7

Comments

As a result of the refurbishment the primary energy demand will be 93.22kWh/m2/year. Therefore, 7 No Credits will be achieved.

Ene 04 Renewable Technologies

No. of BREEAM credits available	2	Available contribution to overall score	2.97%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where the dwelling will meet the following % contribution from renewables and primary energy demand targets as a result of refurbishment

Indicative Credits: 0

Dwelling Type	Primary Energy Demand	Percentage from Renewables	
		1 Credit	2 Credits
Detached	≤ 250 $kWh/m^2/year$	≥10%	≥20%
Semi-Detached		≥10%	≥20%
Bungalow		≥10%	≥20%
End of Terrace		≥10%	≥20%
Mid Terrace	≤ 220 $kWh/m^2/year$	≥10%	≥20%
Low Rise Flat		≥10%	≥20%
Mid Rise Flat		≥10%	≥15%
High Rise Flat		≥10%	≥15%

Comments

These credits are not sought.

Ene 05 Energy Labelled White Goods

No. of BREEAM credits available	2	Available contribution to overall score	2.97%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where Energy Efficiency White goods are to be provided as follows:

Indicative Credits: 2

First Credit

Appliance	Appliance provided	Appliance not to be provided
Fridges, Freezers and Fridge-Freezers	Energy Saving Trust Recommended appliances specified	EU Energy Efficiency Labelling Scheme Information Leaflet provided to all dwellings

Second Credit

Appliance	Appliance provided	Appliance not to be provided
Washing Machines and Dishwashers	Energy Saving Trust Recommended appliances specified	Second credit not achieved
Washer-Dryers and Tumble Dryers	Appliances specified with B Rating under EU Energy Efficiency Labelling Scheme	EU Energy Efficiency Labelling Scheme Information Leaflet provided to all dwellings

Comments

It is assumed that fridges and freezers will be recognised by the Energy Saving recommended labelling scheme, carrying the Energy Saving recommended label. Also washing machines will be recognised by the Energy Saving Trust Recommended labelling scheme, carrying the Energy Saving Trust Recommended Label AND washer dryers and tumble dryers will have a B rating under the EU Energy Efficiency Labelling Scheme. Hence, 2 credits can be awarded.

Ene 06 Drying Space

No. of BREEAM credits available	1	Available contribution to overall score	1.48%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where adequate, secure internal or external space with posts and footings or fixings is provided with the following:

Indicative Credits: 1

1 Credit

Number of bedrooms	Drying line required
1-2	4m+
3+	6m+

Comments

6m+ of drying line will be installed to each of the dwellings (over bath fixed lines). Hence 1 credit can be awarded.

Ene 07 Lighting

No. of BREEAM credits available	2	Available contribution to overall score	2.97%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where energy efficient internal and external lighting is provided as follows:

Indicative Credits: 2

External Lighting - 1 Credit

Energy Efficient Space Lighting of more than 45 lumens per circuit watt and Energy Efficient Security Lighting
OR
Where Energy Efficient Space Lighting is provided ONLY

Internal Lighting - 1 Credit

Maximum average wattage across the total floor area of the dwelling of 9 watts/m2

Comments

1No credit will be achieved since external lighting will be fitted with energy efficient space lighting. The second credit will be achieved since internal lighting will have a maximum average wattage of 9 Watts/m2.

Ene 08 Display Energy Devices

No. of BREEAM credits available	2	Available contribution to overall score	2.97%
No. of BREEAM innovation credits	1	Minimum Standards applicable	No

Assessment Criteria

Where consumption data is displayed to occupants by a compliant energy display device

Indicative Credits: 2

Electricity usage data displayed	Primary Heating Fuel	
	Electricity	Other
Electricity usage data displayed	2 credits awarded	1 credit awarded
Primary Heating Fuel usage data displayed	N/A	1 credit awarded
Electricity & Primary Heating Fuel usage displayed	N/A	2 credits awarded

Exemplary Credits

One credit Recording consumption data	Where the first two credits are achieved Where any compliant Energy Display Device is capable of recording consumption data

Indicative Innovation Credits Achieved: Please Select

Comments

An energy display device will be installed that shows electricity and gas usage data and records consumption data in each flat

Ene 09 Cycle Storage

No. of BREEAM credits available	2	Available contribution to overall score	2.97%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where individual or communal compliant cycle storage is provided as follows:

Indicative Credits: 2

Dwelling Size	One Credit	Two Credits
Studios/ 1 bedroom	1 per two dwellings	1 per dwelling
2-3 bedrooms	1 per dwelling	2 per dwelling
4 bedrooms	2 per dwelling	4 per dwelling

Comments

It has been assumed that a minimum of 16 BREEAM compliant cycle spaces will be provided.

Ene 10 Home Office

No. of BREEAM credits available	1	Available contribution to overall score	1.48%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where sufficient space and services will be provided to allow occupants to set up a home office in a suitable room with adequate ventilation

Indicative Credits: 1

Comments

1 No. credit has been awarded since it is assumed that a home office facility will be provided within the study area .

WATER

Section Weighting: 11% — Indicative Section Score 9.90%

Wat 01 Internal Water Use

No. of BREEAM credits available	3	Available contribution to overall score	6.60%
No. of BREEAM innovation credits	1	Minimum Standards applicable	Yes

Assessment Criteria

Where the dwellings water consumption meets the following consumption benchmarks, or where terminal fittings meet the following water consumption standards:

Indicative Credits: 2.5

Calculated Water Consumption (litres/person/day)	Equivalent terminal fitting standards	Minimum Standard	Credits
>150	Typical baseline performance	N/A	0
from 140 to ≤ 150	All showers specified to 'Good' **OR** All taps and WC's to 'Good' **OR** Kitchen fittings specified to 'Excellent'	N/A	0.5
from 129 to < 140	All showers specified to 'Excellent' **OR** All showers and bathroom taps to 'Good'	BREEAM Very Good	1
from 118 to < 129	All bathroom and WC room fittings specified to 'Good' **OR** All bathroom fittings specified to 'Excellent'	N/A	1.5
from 107 to < 118	All Bathroom and WC room fittings specified to 'Excellent' **OR** All Bathroom fittings Specified to 'Excellent' and WC room fitting specified to 'Good' **OR** All Bathroom fittings, kitchen and utility sittings specified to 'Good'	BREEAM Excellent	2
from 96 to < 107	All kitchen, bathroom, utility room and WC room fittings specified to 'Good' **OR** All bathrooms, kitchens and utility rooms specified to 'Excellent'	N/A	2.5
< 96	All bathroom fittings specified to 'Excellent' and WC room, kitchen and utility room fittings specified to 'Good'	BREEAM Outstanding	3

NOTE: 'Good' fittings are equivalent to good practice fittings with "Excellent" fittings equivalent to best practice fittings (see the technical manual for full details.

Exemplary Credit	If the water consumption is less than 80l/person/day

Indicative Innovation Credits Achieved: Please Select

Comments

It is assumed 2.5 credits will be achieved since internal fittings will comply with a water consumption rate of between 96 and 107 litres/person/day.

Wat 02 External Water Use

No. of BREEAM credits available	1	Available contribution to overall score	2.20%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where the following requirements will be met:

Indicative Credits: 1

Requirements:

One Credit	Where a compliant rainwater collection system for external/internal irrigation use has been provided to dwellings. **OR** Where dwellings have no individual or communal garden space.

Comments

It is assumed 1 credit will be achieved since Rain water butts within the communal garden space will be provided.

Wat 03 Water Meter

No. of BREEAM credits available	1	Available contribution to overall score	2.20%
No. of BREEAM innovation credits	0	Minimum Standards applicable	No

Assessment Criteria

Where an appropriate water meter for measuring usage of mains potable water meter has been provided to dwelling(s), one credit may be awarded

Indicative Credits: 1

Comments

It is assumed that1 credit will be achieved since a water meter will be installed within each flat

MATERIALS	Section Weighting: 8%	Indicative Section Score 4.09%

Mat 01 Environmental Impact of Materials

No. of BREEAM credits available	**25**	**Available contribution to overall score**	**4.44%**
No. of BREEAM innovation credits	**0**	**Minimum Standards applicable**	**No**

Assessment Criteria

Up to 25 credits can be awarded, with credits calculated using the Mat 01 calculator tool. The table below shows the maximum number of credits available for each element:

Indicative Credits: 15

Elements	Green Guide Rating credits available	Thermal performance credits available*
Roof	5	3
External walls	5	3.8
Internal walls (including separating walls)	5	-
Upper and Ground Floor	5	1.2
Windows	5	2

The full 25 credits represents all of the elements containing refurbished or existing materials that meet the Green Guide Rating of A+(6)

GG Rating	Points for existing / refurbished elements	Points for new elements
A+ (6)	5	[redacted]
A+ (5)	4.6	[redacted]
A+ (4)	4.2	[redacted]
A+ (3)	3.8	[redacted]
A+ (2)	3.4	[redacted]
A+	3	3
A	2	2
B	1	1
C	0.5	0.5
D	0.25	0.25
E	0	0

Where the full 25 credits cannot be achieved the score can be 'topped up' with thermal performance credits. The full number of thermal performance credits for each element can be achieved when achieving the minimum U-values shown below.

Elements	Minimum U-Value (W/m2K)
Roof	0.11
External walls	0.15
Internal walls (including separating walls)	-
Upper and Ground Floor	0.15
Windows	1.4

Comments

The internal walls and windows will each attain at least a Green Guide rating of A. Therefore, at least 15No credits will be achieved. Retained elements such as external walls, roof undergoing refurbishment can achieve a maximum of 5 credits where will attain at least a Refurbishment Green Guide Rating of A.

Mat 02 Responsible Sourcing of Materials

No. of BREEAM credits available	**12**	**Available contribution to overall score**	**2.13%**
No. of BREEAM innovation credits	**0**	**Minimum Standards applicable**	**Yes**

Assessment Criteria

Indicative Credits: Please Select

Where new materials are responsibly sourced, up to 12 credits may be awarded where 80% of new materials for an element are responsibly sourced. The credits achieved are dependent on % of point achieved which is based upon the responsible sourcing tier level of each material sourced as detailed below:

Table 1

Tier level	Points
1	4
2	3.5
3	3
4	2.5
5	2
6	1.5
7	1
8	0

Will all new timber used in the project be sourced in accordance with the UK Government's Timber Procurement Yes

Table 2

BREEAM credits	% of available points achieved
12	≥54%
10	≥45%
8	≥36%
6	≥ 27%
4	≥ 18%
2	≥ 9%

Comments

All new timber used in the project will be sourced in accordance with the UK Government's Timber Procurement Policy.

Mat 03 Insulation

No. of BREEAM credits available	**8**	**Available contribution to overall score**	**1.42%**
No. of BREEAM innovation credits	**0**	**Minimum Standards applicable**	**No**

Assessment Criteria

Where any new insulation specified for use within external walls, ground floor, roof and buildings services meet the following requirements:

Indicative Credits: 8

Requirements

4 Credits	Where the Insulation Index for new insulation used in the buildings is ≥2
	Where Green Guide ratings are determined using the Green Guide to specification tool

Requirements

4 Credits	Where ≥ 80% of the new thermal insulation used in the building elements is responsibly sourced.

Comments

8No credits will be achieved since (i) the insulation index for new insulation used in the buildings is ≥2, and the ratings will be determined using the green guide to specification tool. Also, ≥80% of the new thermal insulation will be responsibly sourced.

WASTE

Section Weighting: 3% | Indicative Section Score 2.40%

Was 01 Household Waste

No. of BREEAM credits available	2	**Available contribution to overall score**	1.20%
No. of BREEAM innovation credits	0	**Minimum Standards applicable**	No

Assessment Criteria

Where compliant recycling and composting facilities are provided, up to two credits may be awarded as follows

Indicative Credits: 1

First Credit - Recycling Facilities	
Scenario	**Internal recycling storage requirements**
Compliant collection scheme in place	3 internal recycling containers provided where recycling is not sorted post collection
	1 internal recycling container provided where recycling is sorted post collection
	Minimum 30 litre total capacity, no single container less than 7 litre capacity
	Dedicated position in accordance with compliance note 1
No compliant collection scheme in place No adequate external storage	3 internal recycling containers provided
	Minimum 60 litre total capacity
	Dedicated position in accordance with compliance note 1
No compliant collection scheme in place Adequate external storage provided	3 internal recycling containers provided
	Minimum 30 litre total capacity, no single container smaller than 7 litre capacity
	Dedicated position in accordance with compliance note 1

Second credit - Composting facilities	
With external space	**Without external space**
Where a composting service or facility is provided for green/garden waste	Where a composting service or facility is provided for kitchen waste
Where a composting service or facility is provided for kitchen waste	Where an interior container is provided for kitchen composting waste of at least 7 litres
Where an interior container is provided for kitchen composting waste of at least 7 litres	

Comments

1No credit will be achieved since the dwellings will be provided with 3 internal recycling containers. Overall capacity will be a minimum of 30 litres.

Was 02 Refurbishment Site Waste Management

No. of BREEAM credits available	3	**Available contribution to overall score**	1.80%
No. of BREEAM innovation credits	1	**Minimum Standards applicable**	No

Assessment Criteria

Up to three credits are available depending on the site waste management plan to be implemented as follows

Indicative Credits: 3

Indicative Innovation Credits Achieved: Please Select

Projects up to £100k

Three Credits	Where waste generated through the refurbishment process is managed in accordance with Checklist A-9
Exemplary Credit	Where a compliant Level 1; Site Waste Management Plan (SWMP) is in place

Projects up to £300k

Three Credits	Where a compliant Level 1; Site Waste Management Plan (SWMP) is in place
Exemplary Credit	Where a compliant Level 2; Site Waste Management Plan (SWMP) is in place
	Non-hazardous construction waste generated by the dwellings refurbishment meets or exceeds the resource efficiency benchmark
	The percentage of non-hazardous construction waste and demolition waste generated by the project has been diverted from landfill and meets or exceeds the refurbishment & demolition waste diversion benchmarks

Projects over £300k

First Credit Management Plan	Where a compliant Level 2; Site Waste Management Plan (SWMP) is in place
Second Credit Good Practice Waste Benchmarks	First credit achieved
	Non-hazardous construction waste generated by the dwellings refurbishment meets or exceeds the resource efficiency benchmark
	Amount of waste generated against £100,000 of project value is recorded in the SWMP
	Pre-refurbishment audit of the existing building is completed
	If demolition is included as part of the refurbishment programme, then the audit should also cover demolition materials
Third Credit Best Practice Waste Benchmarks	Where the first two credits have been achieved achieved
	Where Non-hazardous demolition waste generated by the dwellings refurbishment meets or exceeds the refurbishment & demolition waste diversion benchmarks
Exemplary Credit	Where non-hazardous construction waste generated by the dwellings refurbishment meets or exceeds the *exemplary level resource efficiency benchmark*
	Where Non-hazardous demolition waste generated by the dwellings refurbishment meets or exceeds the exemplary level diversion benchmarks

Comments

The principal contractor will ensure that a BREEAM compliant SWMP will be in place. Syntegra Consulting would be able to provide consultation to achieve the required credits. This credit will have to be achieved in order to comply with planning policy requirements.

POLLUTION

Section Weighting: 6% | Indicative Section Score 2.25%

Pol 01 NOx Emissions

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

Assessment Criteria

Credits are awarded on the basis of NOx emissions arising from the operation of space heating and hot water systems for each refurbished dwelling as follows:

Indicative Credits: 0

	Dry NOx Emissions
One Credit	≤100 mg/kWh (NOx class 4 boiler)
Two Credits	≤70 mg/kWh (NOx class 5 boiler)
Three Credits	≤40 mg/kWh

Comments

Communal ASHP have been recommended and hence no credits can be achieved.

Pol 02 Surface Water Runoff

No. of BREEAM credits available	3	**Available contribution to overall score**	2.25%
No. of BREEAM innovation credits	1	**Minimum Standards applicable**	No

Assessment Criteria

Where impacts of the refurbishment on surface water runoff are neutralised or where runoff is reduced as a result of refurbishment, up to three credits can be awarded as follows:

Indicative Credits: 1

Credits	Requirements
One Credit Neutral Impact on Surface Water	New hard standing areas must be permeable
	If building on to previously permeable area additional run-off must be managed on site
	Calculations should be carried out by an appropriately qualified professional
OR Second Credits Reducing Run-Off From Site: Basic	Where the criteria needed for One Credit has been achieved
	Where all run-off from the roof for rainfall depths up to 5 mm, have been managed on site using source control methods
	Include runoff from all existing and new parts of the roof.
	An appropriately qualified professional should be used to design an appropriate drainage strategy for the site
OR Three Credits Reducing Run-Off From Site: Advanced	Where run-off as a result of the refurbishment is managed on site using source control
	An appropriately qualified professional should be used to design an appropriate drainage strategy for the site.
	The peak rate of run-off as a result of the refurbishment for the 1 in 100 year event has been reduced by 75% from the existing site.
	The total volume of run-off discharged into the watercourses and sewers as a result of the refurbishment, for a 1 in 100 year event of 6 hour duration has been reduced by 75%.
	An allowance for climate change must be included for all of the above calculations, in accordance with current best practice (PPS25, 2010).
Exemplary Credit	Where all run-off from the developed site is managed on site using source control
	The peak rate of run-off as a result of the refurbishment for the 1 in 1 year event is reduced to zero.
	The peak rate of run-off as a result of the refurbishment for the 1 in 100 year event is reduced to zero.
	There is no volume of run-off discharged into the watercourses and sewers as a result of the refurbishment, for a 1 in 100 year event of 6 hour duration.
	An allowance for climate change must be included for all of the above calculations, in accordance with current best practice (PPS25, 2010).

Indicative Innovation Credits Achieved: Please Select

Comments

1 No. credit has been assumed since the development will have SUDS strategy implemented. It is also assumed that calculations by a qualified Hydrologist will be provided at design stage.

Pol 03 Flooding

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

Assessment Criteria

Where the dwelling is located in a low flood risk zone, or where in a medium to high flood risk zone and a flood resilience/resistance strategy has been implemented, up to two credits can be awarded as follows:

Indicative Credits: 2

Minimum Standards	A minimum of two credits must be achieved for this issue at the Excellent and Outstanding levels
Option 1 - Low Flood Risk	
Two Credits	Where a Flood Risk Assessment (FRA) has been carried out and the assessed dwellings are defined as having a low annual probability of flooding.
Option 2 - Medium / High Flood Risk	
Two Credits	Where a Flood Risk Assessment (FRA) has been carried out and the assessed dwellings are defined as having a medium or high annual probability of flooding.
	Two credits are awarded where as a result of the dwellings floor level or measures to keep water away the dwelling is defined as achieving avoidance from flooding by following Checklist A-10; Decision Strategy Flow Chart.
	Where avoidance is not possible, two credits are achieved where a full flood resilience/resistance strategy is implemented for the dwellings in accordance with recommendations made by a Suitably Qualified Building Professional

Comments

A Flood Risk Assessment will be undertaken for the development by a qualified Hydrologist. According to the Environment agency the site is expected to be of high flooding risk. Hence, two credits can be awarded if the dwellings will be defined as having a high annual probability of flooding.