SYNTEGRA
CONSULTING

Garages to the south of 27A West End Lane
New Build Energy and Sustainability Report

15-1818

27A West End Lane, London, NW6 4QJ

29/09/2015

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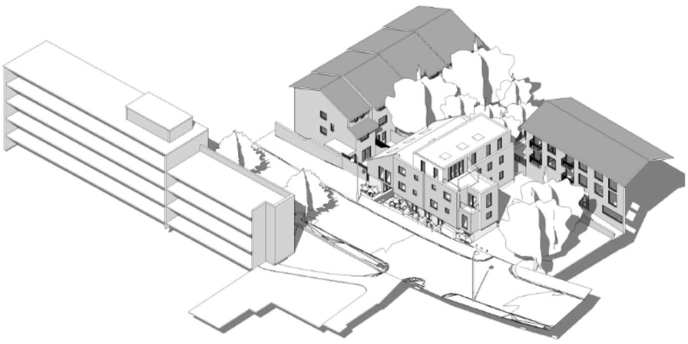

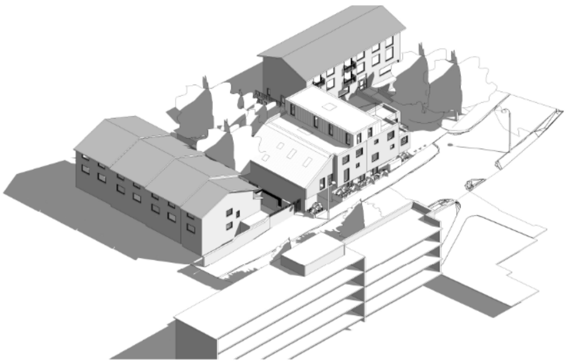

Revision	*A*
Date	29/09/20105
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The methodology adopted and the sources of information used by SC in providing its services are outlined in this report. The work described in this report was undertaken in **September 2015** and is based on the conditions encountered and the information available during the said period of time. The scope of this report and the services are accordingly factually limited by these circumstances.

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1. Executive Summary

The design of the proposed development of the **Garages to the south of 27A West End Lane**, will be comprised of **6 new residential units (flats)** located in **West Hampstead, in the Borough of Camden, London**. The design has incorporated building fabric enhancement (above and equal to current building regulations requirements) to increase the energy efficiency of the building. This includes that the development uses less energy, by adopting sustainable design and construction measures and by supplying energy efficiently.

Given the complexity of calculating and assessing CO_2 emissions, the **London Borough of Camden** requires all proposed developments to incorporate sustainable design and construction measures. Schemes must demonstrate how sustainable development principles have been incorporated into the design and proposed implementation. **In accordance with Camden Council's Sustainability Planning Guidance (CPG 3) and the pre-application advice provided by officers (Ref:2015/2841/PRE) all new residential developments are required to meet, as a minimum, Code for Sustainable Homes Level 4. This also includes further requirements including: at least a 25% improvement in carbon emissions over Building Regulations Part L1A baseline as well as a maximum internal water usage of 105 litres per person per day. With reference to Camden Council Core Strategy 2010-2025 policy CS13.11 '*Generating renewable technology on-site*' all new developments are expected to have a reduction in carbon emissions of 20% through on-site renewable technologies.**

The recommendation for the proposed development is that at least **90% Efficient, Individual, Combination gas boilers be installed in each flat along with a total of 6kWp of PV (equalling 24 panels and equating to a total of approximately 38.64m2 of required roof space) for the development as a whole (1kWp for each flat).** The proposed strategy provides the following attributes:

1. The strategy would provide an area weighted average of **25.54% CO_2 reduction saving against the Part L1A 2013 baseline. Therefore, the strategy shows compliance with Criterion 1 of Part L 2013 for carbon emissions and mandatory Code level 4 requirements for energy.**

2. The strategy would provide **an average 28.57% reduction of CO_2 emissions via onsite renewable technology (photovoltaics) for the overall development. Hence, the required target of 20% reduction in CO_2 emissions through onsite renewable has been achieved**.

3. The strategy shows an **improvement of 6.3% in Fabric Energy Efficiency (FEE) compared to the Part L 2013 baseline**, therefore compliance with Criterion 1 of Part L 2013 for FEE can be demonstrated**.**

4. Separate CSH pre-assessments have been undertaken for each new residential units of the development. **The CSH pre-assessment demonstrates that a "Code level 4" rating can be achieved for the proposed development** [See appended CSH pre-assessment for further detail].

5. After the application of the proposed strategy, the regulated carbon dioxide emissions are presented on the table below:

	Carbon Dioxide emissions (Tonnes CO_2 per annum)
	Regulated
Baseline: Building Regulations 2013 Part L Compliant Development	16.74
After energy demand reduction	17.47
After CHP/ Communal Heating	-
After renewable energy	12.48

Table 1: Carbon dioxide Emissions after each stage of the proposed strategy

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

	Regulated Carbon Dioxide savings	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction	-0.38	-4.25%
Savings from CHP/ Communal Heating	-	-
Savings from Renewable energy	2.69	28.57%
Total Cumulative Savings	**2.31**	**25.54%**
Total Target Savings	2.26	25%
Annual Surplus	0.05	

Table 2: Regulated carbon dioxide savings from each stage of the proposed strategy

6. **Meeting the Policy Requirements:**

- **The carbon saving attributable to energy efficiency measures:** -4.25%
- **The carbon saving attributable to renewable energy technologies:** 28.57% - Therefore meets the 20% improvement through on-site renewables.
- **The proposed development's overall improvement over the baseline:** 25.54% - As can be seen from the table above, the development meets the 25% target required for Code level 4.

2. Introduction

Syntegra Consulting Ltd has been appointed as sustainability consultants to produce an energy strategy for the **6 New Build Residential Units (flats)** for the scheme at **'Garages to the south of' 27A West End Lane, West Hampstead, London** – to support the scheme design process, demonstrate Building regulations Part L1A 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 & CO_2 emissions. It will look into the feasibility of Low Zero Carbon technologies, examining the following aspects relative to LZC/renewable technologies:

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

2) The **Code for Sustainable Homes (CSH) pre-assessment strategy** (under the current CSH Addendum 2014 guide) in terms of the intent in achieving the **overall minimum Code Level 4** strategy for the development. – In accordance with 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). Demonstration of how the design is compliant against the current Part L1A 2013 buildings regulations i.e. **an improvement of the proposed dwelling regulated carbon emissions of 25% compared to the notional dwelling emissions as set by Part L 2013**, as required to achieve Code level 4 for the ENE1 category of the Code for Sustainable Homes assessment – In accordance with local planning policy targets.

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 two to four storey development will be comprised of **6 No. New Build Residential Units (Flats)**. The development is located in the area of West Hampstead in London and it is in close proximity to Kilburn High Road station (approx 0.2 miles), Kilburn Park Underground station (approx 0.4 miles), South Hampstead and Queens Park stations' (both approx. 0.8 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 2013 (Policy 5.2, 5.6, 5.7 & 5.9)

The Mayor and boroughs should in their DPDs adopt a presumption that developments will achieve a reduction in carbon dioxide emissions of 20% from onsite renewable energy generation according to paragraph 5.42 of Policy 5.7 Renewable Energy (which can include sources of decentralised renewable energy). According to Policy 5.2 (clause B) all 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 and utilizing a Combined Heat & Power according to Policy 5.6 and reducing the potential for overheating and reliance on air conditioning systems according to Policy 5.9.

4.3. London Borough of Camden Local Policies

Camden

Camden Local Development Framework (LDF): Development Policies 2010
Section 3 - A sustainable and attractive Camden

Policy DP22: 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. 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;

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.

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.

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:

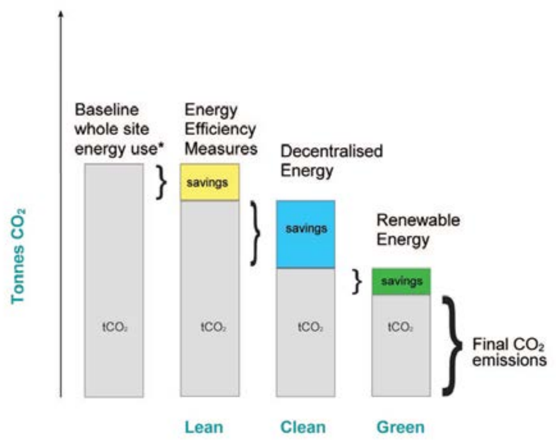
- *Using less energy, in particular by adopting sustainable design and construction measures;*
- *Supplying energy efficiency, in particular by prioritising decentralised energy generation; and*
- *Using renewable energy.*

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	2	79.77
2	Flat 2	Ground Floor	1	59.17
3	Flat 3	1st Floor	2	77.45
4	Flat 4	1st Floor	3	120.76
5	Flat 5	2nd Floor	1	63.69
6	Flat 6	2nd and 3rd Floor	3	137.72
Total	**-**	**-**	**12**	**538.56**

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	Proposed Specification
External Walls U-value	0.16
Window units (whole window) U-value	1.2 Double Glazing
Floor U-value	0.13
Flat & Pitched Roof U-value	0.13
Air Permeability m^3/(h.m^2) at 50 Pa	4
Low Energy Lighting	100%

Table 2

The original U-value of 1.4 for the windows had to be changed and reduced to 1.2 to pass Building Regulations as flat 2 was failing on fabric energy efficiency. The reason this had to be dealt with was due to fabric energy efficiency not being legible for offset through renewable technologies.

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 L1A 2013).**

Carbon Emissions Factor	SAP 2013 kgCO2/kW
Grid Electricity	0.445
Coal (traditional British Coal)	0.313
Heating Oil	0.245
LPG	0.214
Natural Gas	0.184
Wood Pellets	0
Bio Diesel	0.245
Petrol	0.234

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 ADL1A 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 ADL1A 2013 document (Table 4).

	ADL1A 2013 min. required values	Proposed building values
Air Permeability $m^3/(h.m^2)$ at 50 Pa	5	4
Wall U value W/m^2C^0	0.18	0.16
Roof U value W/m^2C^0	0.13	0.13
Floor U value W/m^2C^0	0.13	0.13
Window U value W/m^2C^0	1.4	1.2

Table 4

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

Building Services	Baseline CO_2 Emissions ($kg\ CO_2/m^2/yr$)
Heating	8.55
Auxiliary	0.43
Lighting	2.23
Hot Water	5.55
Total regulated emissions	**16.76**

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)	**16.76**	**9.03**

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	Baseline CO_2 Emissions (kg $CO_2/m^2/yr$)	BE LEAN Building CO_2 Emissions (kg $CO_2/m^2/yr$)
Heating	8.55	9.21
Auxiliary	0.43	0.43
Lighting	2.23	2.19
Cooling	-	-
Hot Water	5.55	5.64
Total regulated emissions	**16.76**	**17.47**

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 $CO_2/m^2/yr$	**16.76**	**17.47**	
Tonnes CO_2/ yr	**9.03**	**9.41**	**-4.25%**

From the table above it can be seen that the overall CO_2 reduction due to energy efficiency is ***-4.25%*** 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 = 0.16 (better than Building Regs)
- Floor u-value = 0.13 (equal to Building Regs)
- Roof u-value = 0.13 (equal to Building Regs)
- Windows u-value = 1.2 - double glazing (better than Building Regs)
- Air permeability = 4 m3/m2/hr (better than Building Regs)
- 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

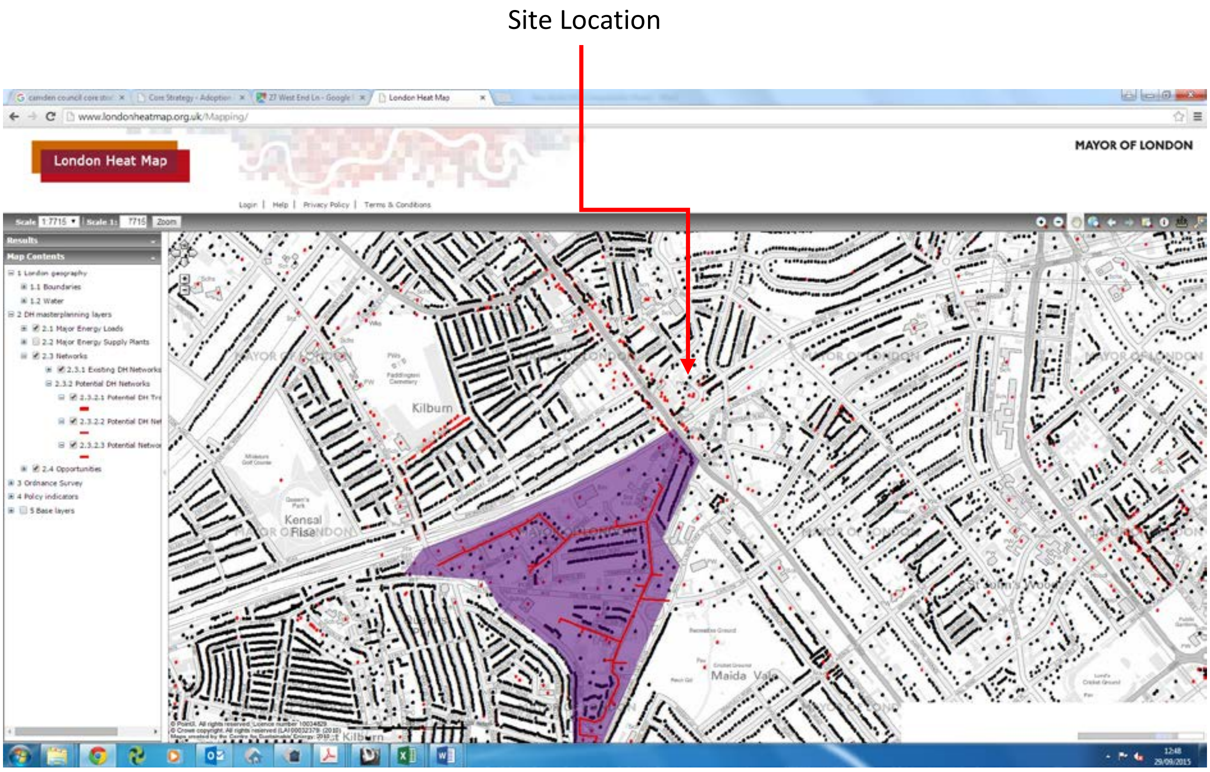
Micro CHP has not been considered further for this project due to the following reasons:

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 London Borough of Camden Council favour community heating schemes as they have the ability to reduce carbon dioxide emissions by between 30-40% and are increasingly pushing developments to incorporate such schemes. Camden Council are pushing this by making it a requirement for developments to connect to a decentralised energy network if it is feasible or viable.

The feasibility of this proposed development of the garages to the south of 27A West End Lane of connecting into an existing heating network has been assessed alongside the **London Heat Map Study for the London Borough of Camden (2010)** as part of this assessment.



The study identified the area of the development on West End Lane with a potential District Heating network, however 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.

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
- Air Source Heat Pumps

9.1. Photovoltaic (PV) – Proposed Technology

Photovoltaic panels are the proposed renewable technology 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 11.71p per kWh for electricity generated and 4.85p per kWh for electricity exported back to the grid (over 20 years).

<u>For the proposed 6 residential units the following options has been examined and proposed</u>:

- **Option: Individual Condensing Gas Boilers + 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 : Individual Combi gas boilers + 6kWp (for the development as a whole)**

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

Orientation	South	**Number of Panels**	**24**
Panel Tilt	30^o	**Manufacturer**	Canadian Solar
Overshading	Less than 20 percent	**Model**	CS6P-250M
Proportion Exported	50%	**Type**	Monocrystalline
Build Type	New	**Area**	1.61 m^2
Energy Efficiency	EPC valid and at least Band D or higher	**Power Output**	250 Wp
Installation Type	Multi-installation		

System Specification :	**6 kWp**
Total Roof Area Required :	**38.64 m^2**
Annual Electricity Ouput :	**5178 kWh**

This table above shows the proposed PV specification for the new residential units. It will generate 5178 kWh per year. For the 6kWp system, 24 high efficiency 250W monocrystalline PV panels need to be installed. The roof area required for the PV panels is approximately 38.64m^2.

<u>6 kWp Solar PV for ROI model below</u>

<u>Note: PV panels are based on high output, high efficiency at 250 Watts/panel.</u>

Based on the details above we estimate your annual income and overall investment payback to be as follows:

Investment in 6.00kWp System: *		£ 5,429.61
First Year:	Income from Feed-In Generation Tariff @ 11.71p/kWh:	£ 606.35
	Income from exporting energy @ 4.85p/kWh:	£ 125.57
	Electricity Saving:	£ 350.04
	Total Benefit:	£ 1,081.96
Payback Time:		4y 8m
Total Profit Over 20 years:		**£ 26,210.66 24.14 % per year (8.81% 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 quotes.
- Assuming that you pay 11.71p per unit and that around 50% 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: Combi gas boilers + 6kWp PV BE GREEN stage

Building Services	BE LEAN CO_2 Emissions (kg $CO_2/m^2/yr$)	BE GREEN Building CO_2 Emissions (kg $CO_2/m^2/yr$)
Heating	9.21	9.21
Auxiliary	0.43	0.43
Lighting	2.19	2.19
Cooling	-	-
Hot water	5.64	5.64
Energy generated by renewables	**-**	**-4.99**
Total regulated emissions	**17.47**	**12.48**

CO_2 Reductions after BE GREEN stage

Regulated Emissions	BE LEAN Building CO_2 Emissions	BE GREEN Building CO_2 Emissions	% reduction in CO_2 Emissions
kgr of $CO_2/m^2/yr$	**17.47**	**12.48**	
Tonnes CO_2/ yr	**9.41**	**6.72**	**28.57%**

From the table above it can be seen that the overall CO_2 reduction due to energy efficiency is ***28.57%*** for the total emissions.

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 in place of the **garages to the south of 27A West End Lane, West Hampstead, Camden, NW6** is that at least **90% Efficient, Individual Combination gas boilers be installed for the residential units. In addition, a total of 6kWp PV (which equals to 24 PV panels in total and approximately 38.64m^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 Canadian Solar 250 watts.
2. The strategy would provide an average of **25.54% CO_2 reduction saving (DER/TER) against current building regulations for the new residential units. Therefore, the strategy meets BRUK-L1A 2013 requirements for the development and the Code level 4 target of 25% CO_2 reduction saving (DER/TER) against 2013 building regulations.**
3. The strategy would also provide **an average 28.57% reduction of CO_2 emissions the energy demand via onsite renewable technology (PV) for the overall development. Hence, the required target of 20% reduction in CO_2 emissions through renewable onsite has been achieved**.
4. A separate CSH pre-assessment has been undertaken for the new residential units of the development. **The CSH pre-assessment demonstrates that a "Code level 4" rating can be achieved for all the dwellings** [See the Appendix for the CSH 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
Baseline: Building Regulations 2013 Part L Compliant Development	16.76
After energy demand reduction	17.47
After CHP/ Communal Heating	17.47
After renewable energy	12.48

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	-0.38	-4.25%
Savings from CHP/ Communal Heating	-	-
Savings from Renewable energy	2.69	28.57%
Total Cumulative Savings	**2.31**	**25.54%**
Total Target Savings	**2.26**	**25%**
Annual Surplus	**0.05**	

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 renewable energy technologies:** 28.57%
- **The proposed development's overall improvement over the baseline:** 25.54% - As can be seen from the table above, the development meets the 25% target.

11. Appendix

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

11.1. Low & Zero Carbon Energy Systems

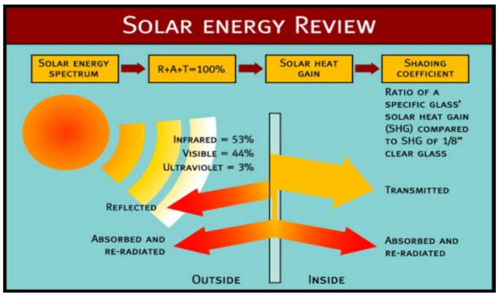
The following section is an overview of the LZC energy systems that are available and can be implemented to the building environment. Firstly, a brief description of the types of renewable energy (zero carbon energy) that can be harnessed with technology will be presented. In addition, the renewable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

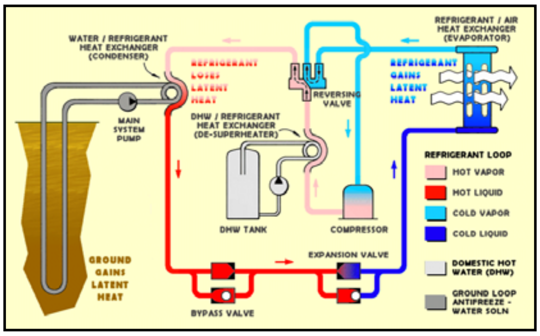
- ✓ **Bio-energy**

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**

Description of PV Systems

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

Thin film solar cells use layers of semiconductor materials only a few micrometers thick. Thin film technology has made it possible for solar cells to now double as rooftop shingles, roof tiles, building facades, or the glazing for skylights or atria.

The solar cell version of items such as shingles offer the same protection and durability as ordinary asphalt shingles.

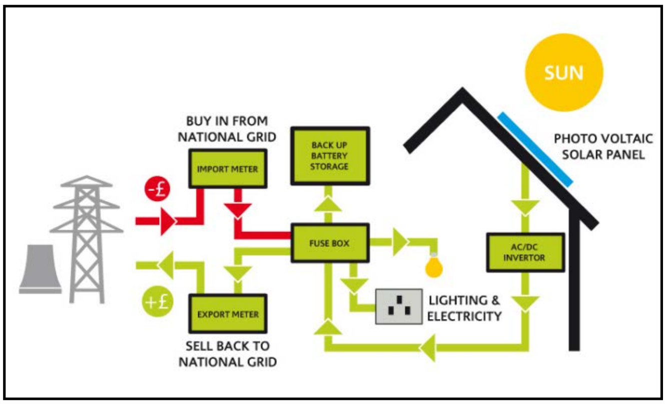
Advantages

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

Best Practice Design

PV installations performance is proportional to the active area (area covered by PVs). The desirable location for PV panels is on a south facing roof or façade, as long as no other building or tall trees overshadows it, resulting in reduced PV efficiency. PV panels are 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

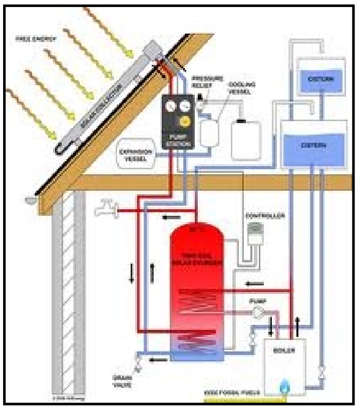
Table 4

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 Considerations



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 Considerations

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 Considerations

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.

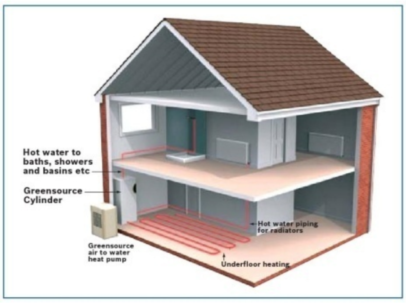
- Air Source Heat Pumps
- Ground Source Heat Pumps (GSHP)
- Combined Heat and Power (CHP)
- Micro CHP
- Fuel Cells

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

Description of Air Source Heat Pumps

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

Advantages



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

Costs & Savings

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

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.

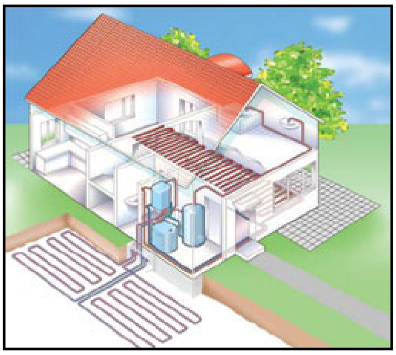
The RHI is in two phases:

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 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.

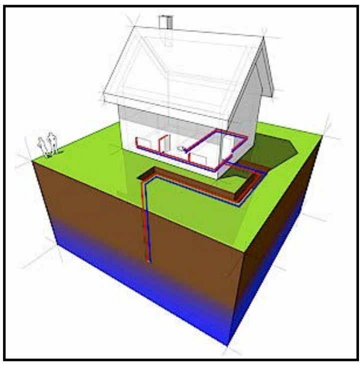
11.2.1.8. Ground Source Heat Pumps (GSHP)

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

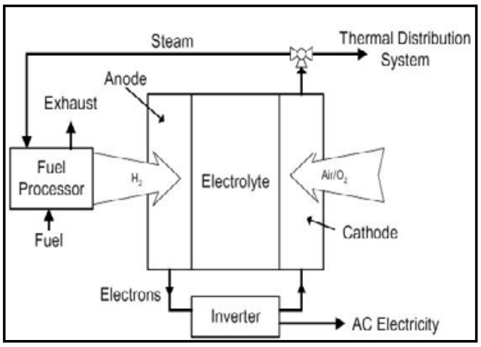
Even better, since fuel cells create electricity chemically, rather than by combustion, they are not subject to the thermodynamic laws that limit a conventional power plant. Therefore, fuel cells are more efficient in extracting energy from a fuel. Waste heat from some cells can also be harnessed, boosting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

SYNTEGRA
CONSULTING

Garages to the south of 27A West End Lane Code for Sustainable Homes Pre-assessment

27A West End Lane, West Hampstead, London, NW6 4QJ

29/09/2015

Ref: 15-1818

Audit Sheet				
Revision	**Description**	**Author**	**Reviewer**	**Issue Date**
A	Initial issue for review by the project team. Target is Level 4.	J. Sewell	A. King	29.09.2015

Contents

1. Executive Summary

This report contains the initial pre-assessment carried out for the development of the garages to the south of 27A West End Lane, West Hampstead, London, NW6 4QJ, hereafter referred to as the Proposed Development, under Code for Sustainable Homes. The proposed development is required to target Level 4 In accordance with Camden Council's Sustainability Planning Guidance (CPG 3) and the pre-application advice provided by officers (Ref:2015/2841/PRE).

The current targeted score is 68.60 %, which is equivalent to a '4', with a margin of 0.60%. A margin of 3-5% is recommended above the minimum required score to ensure that the targeted rating is achieved at the following stages.

Possible additional credits have been identified throughout this report. If these potential credits were targeted the score would be 75.83%, thus increasing the margin above the targeted Level and further securing the score.

Table 1.1 highlights the targeted score and the awarded score.

Table 1.1 – Targeted and Potential Score		
27A West End Lane	**Score**	**Level**
Targeted Score	68.60	4
Potential Score	75.75	4

2. Code for Sustainable Homes

2.1. Introduction

The Code for Sustainable Homes is an environmental assessment method for rating and certifying the performance of new homes. It is a national standard for use in the design and construction of new homes with a view to encourage continuous improvement in sustainable home building.

CSH covers nine categories of sustainable design:

- Energy and CO2 emissions
- Water
- Materials
- Surface Water Run-Off
- Waste
- Pollution
- Health and Wellbeing
- Management
- Ecology

Each issue covered in in the categories above is a source of environmental impact which can be assessed against a performance target. Performance targets are more demanding than the minimum standard needed to satisfy Building Regulations or other legislation. They represent ‘Good Practice’, are technically feasible and can be delivered by the building industry.

2.2. Mandatory Credit Issues

There are mandatory credits set which must be achieved in order to achieve the difference performance Levels. These must be achieved in addition to the optional credits to achieve the targeted ratings.

Failure to meet the mandatory criteria may restrict a development to an UNCLASSIFIED rating, regardless of the overall percentage achieved.

Category	CSH Level	1	2	3	4	5	6
	Minimum Score	36	48	57	68	84	90
Energy	Ene 1: Dwelling emission rate	-	-	-	3 credit	9 credits	10 credits
	Ene 2: Fabric energy efficiency	-	-	-	-	7 credits	7 credits
Water	Wat 1: Indoor water use	1 credit	1 credit	3 credits	3 credits	5 credits	5 credits
Materials	Mat 1: Environmental Impact of Materials	Pre-requisite	Pre-requisite	Pre-requisite	Pre-requisite	Pre-requisite	Pre-requisite
Surface Water Run-off	Sur 1: Management of surface water run-off from developments	Pre-requisite	Pre-requisite	Pre-requisite	Pre-requisite	Pre-requisite	Pre-requisite
Waste	Was 1: storage of non-recyclable waste and recyclable household waste	Pre-requisite	Pre-requisite	Pre-requisite	Pre-requisite	Pre-requisite	Pre-requisite
Health and Wellbeing	Hea 4: Lifetime Homes	-	-	-	-	-	4 credits

2.3. CSH Credit Weightings

The weightings for the associated credits depending on the assessment route are shown in Table 2.2 below.

Table 2.2: Credit Weightings			
Category	**Credits available**	**Section Weighting**	**Individual credit weighting**
Energy	31	36.4%	1.17
Water	6	9.0%	1.50
Materials	24	7.2%	0.30
Surface Water Run-off	4	2.2%	0.55
Waste	8	6.4%	0.80
Pollution	4	2.8%	0.70
Health and Wellbeing	12	14.0%	1.17
Management	9	10.0%	1.11
Ecology	9	12.0%	1.33

3. Summary Indicative Assessment Score Sheet

The credits assumed in the pre-assessment score and associated weighting are shown in the score breakdown below.

Table 3.1: Indicative Pre-assessment score

Category	Credits available	Credits Targeted	Potential Credits	Weighted Score (Potential)
Energy	31	17.9	18.9	20.94 (22.11)
Water	6	4	5	6 (7.5)
Materials	24	8	13	2.4 (3.9)
Surface Water Run-off	4	4	4	2.2
Waste	8	8	8	6.4
Pollution	4	3	4	2.1 (2.8)
Health and Wellbeing	12	10	11	11.7 (12.87)
Management	9	8	9	8.88 (9.99)
Ecology	9	6	6	7.98
Total			**Total Targeted Score**	**68.60**
			Total Potential Score	**75.75**

4. Detailed Credit Assessment

4.1. Energy

<table>
<tr><th>Credit</th><th>Description</th><th>Credits Available</th><th>Credits Targeted</th><th>Responsible party</th><th>Comment</th></tr>
<tr><td>Ene 1</td><td><u>Dwelling Emission Rate (England)</u>

To limit CO2 emissions arising from the operation of a dwelling and its services in line with current policy on future direction of regulations.
<table>
<tr><th>% improvement on Part L 2013</th><th>Credits</th><th></th></tr>
<tr><td>>6%</td><td>1</td><td></td></tr>
<tr><td>>12%</td><td>2</td><td></td></tr>
<tr><td>>19%</td><td>3</td><td>Level 4</td></tr>
<tr><td>>32%</td><td>4</td><td></td></tr>
<tr><td>>44%</td><td>5</td><td></td></tr>
<tr><td>>56%</td><td>6</td><td></td></tr>
<tr><td>>70%</td><td>7</td><td></td></tr>
<tr><td>>84%</td><td>8</td><td></td></tr>
<tr><td>>100%</td><td>9</td><td>Level 5</td></tr>
<tr><td>Zero net emissions</td><td>10</td><td>Level 6</td></tr>
</table>
</td><td>10</td><td>3.5</td><td>Sustainability Consultant
+
Architect</td><td>Taken from the SAP calculations included in the Energy Strategy Report.

See: Energy Strategy Report</td></tr>
</table>

<table>
<tr><th>Credit</th><th>Description</th><th>Credits Available</th><th>Credits Targeted</th><th>Responsible party</th><th>Comment</th></tr>
<tr><td>Ene 2</td><td><u>Fabric Energy Efficiency (England)</u>

To improve fabric energy efficiency performance thus future proofing reductions in CO_2 for the life of the dwelling.
<table>
<tr><th colspan="2">Dwelling Type (kWh/m²/yr)</th><th rowspan="2">Credits</th><th rowspan="2"></th></tr>
<tr><th>Flats or mid terrace</th><th>End terrace, semi-detached or detached</th></tr>
<tr><td>>48</td><td>>60</td><td>3</td><td></td></tr>
<tr><td>>45</td><td>>55</td><td>4</td><td></td></tr>
<tr><td>>43</td><td>>52</td><td>5</td><td></td></tr>
<tr><td>>41</td><td>>49</td><td>6</td><td></td></tr>
<tr><td>>39</td><td>>46</td><td>7</td><td>Level 5 & 6</td></tr>
<tr><td>>35</td><td>>42</td><td>8</td><td></td></tr>
<tr><td>>32</td><td>>38</td><td>9</td><td></td></tr>
</table></td><td>9</td><td>3.4</td><td>Sustainability Consultant
+
Architect</td><td>SAP calculations show an average Fabric Energy Efficiency (FEE) of 46.56 across all flats therefore 3.4 credits are targeted.</td></tr>
</table>

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Ene 3	**<u>Energy Display Devices</u>** 1 Credit: Where current electricity OR primary heating fuel consumption data are displayed to occupants by a correctly specified energy display device. 2 Credits: Where current electricity AND primary heating fuel consumption data are displayed to occupants by a correctly specified energy display device. *<u>Default Cases</u>* *Where electricity is the primary heating fuel and current electricity consumption data are displayed to occupants by a correctly specified energy display device both credits can be awarded*	2	2	Developer	It has been assumed that a compliant energy display device will be installed that measures: - Local time - Current mains energy consumption - Current emissions - Current tariff - Current cost - Display accurate account balance information - Visual representation of data - Historical consumption data Syntegra can provide these if necessary. To be confirmed by the development team.
Ene 4	**<u>Drying Space</u>** Where space and equipment are provided for drying clothes: • For 1 – 2 bedroom dwellings, the drying equipment must be capable of holding 4m+ of drying line • For 3+ bedroom dwellings, the drying equipment must be capable of holding 6m+ of drying line The drying space (internal or external) must be secure	1	1	Architect + Developer	It has been assumed that compliant internal drying space will be provided that is: - Of the required length (1-2 bedrooms = 4m+) - Adequate ventilation provided - Is permanently fixed

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Ene 5	**Energy Labelled White Goods** 1 Credit : Where the following appliances are provided and have an A+ rating under the EU Energy Efficiency Labelling Scheme: • Fridges and freezers or fridge-freezers 1 Credit: Where the following appliances are provided and have an A rating under the EU Energy Efficiency Labelling Scheme: • Washing machines and dishwashers AND EITHER • Tumble dryers or washer dryers have a B rating (where a washer dryer is provided, it is not necessary to also provide a washing machine) OR • EU Energy Efficiency Labelling Scheme Information is provided to each dwelling in place of a tumble dryer or a washer dryer Where no white goods are provided but EU Energy Efficiency Labelling Scheme Information is provided to each dwelling 1 credit can be awarded. Note: To obtain this credit, any white goods available to purchase from the developer must be compliant with the above criteria.	2	2	Developer	It has been assumed that the following specification will be met for the white goods provision of this development: - Fridges + freezers or fridge freezers of EU A+ rated standard - Washing machine A rated - Dishwasher A rated - Tumble dryer / washer dryer B rated Or where not provided, EU labelling literature will be provided to the occupant To be confirmed by the development team

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Ene 6	**External Lighting** 1 credit: Space Lighting Where all external space lighting, including lighting in common areas, is provided by dedicated energy efficient fittings with appropriate control systems. Note: Statutory safety lighting is not covered by this requirement 1 credit: Security Lighting Where all security lighting is designed for energy efficiency and is adequately controlled such that: All burglar security lights have: • A maximum wattage of 150 W AND • Movement detecting control devices (PIR) AND • Daylight cut-off sensors All other security lighting: • Is provided by dedicated energy efficient fittings AND • Is fitted with daylight cut-off sensors OR a time switch This credit can be awarded by default if no security lighting is installed	2	2	Lighting Designer	Assumed that compliant space lighting will be installed allowing 2 credits to be targeted To be confirmed by the development team

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Ene 7	**<u>Low and Zero Carbon Technologies</u>** Where energy is supplied by low or zero carbon technologies AND 1 Credit: There is a 10% reduction in CO_2 emissions as a result OR 2 Credit: There is a 15% reduction in CO_2 emissions as a result	2	2	Sustainability Consultant + Mechanical Engineer	With reference to the SAP calculations and Energy Strategy Report, all flats achieve a reduction in CO2 emissions of greater than 15% therefore both credits have been targeted.

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Ene 8	**Cycle Storage** **1 Credit**: Where individual or communal cycle storage is provided, that is adequately sized, secure and convenient, for the following number of cycles: Studios or 1 bedroom dwellings – storage for 1 cycle for every two dwellings 2 and 3 bedroom dwellings –- storage for 1 cycle per dwelling 4 bedrooms and above –- storage for 2 cycles per dwelling OR **2 Credits:** Studios or 1 bedroom dwellings – storage for 1 cycle per dwelling 2 and 3 bedroom dwellings – storage for 2 cycles per dwelling 4 bedrooms and above – storage for 4 cycles per dwelling Note: The requirements for secure cycle storage are met where compliance with clause 35 of Secured by Design (SBD) New Homes 2010 is achieved.	2	2	Developer + Architect	Has been confirmed that the cycle storage will have a double stacking bike rack allowing space for a total of 12 bikes. This means that both credits have been targeted.

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Ene 9	**Home Office** Where sufficient space and services have been provided which allow occupants to set up a home office in a suitable room. The space dedicated for use as a home office must have adequate ventilation and achieve an average daylight factor of 1.5%.	1	1	Daylighting Consultant + Architect	Assumed that there will be a suitable home office. (I.e. 2 double power sockets, two telephone ports or one telephone port where cable/broadband is available, a window and adequate ventilation) Adequate ventilation – openable area of $0.5m^2$ Daylight calculations to confirm this

4.2. Water

<table>
<tr><th>Credit</th><th>Description</th><th>Credits Available</th><th>Credits Targeted</th><th>Responsible party</th><th>Comment</th></tr>
<tr><td>Wat 1</td><td>Indoor Water Use
<table>
<tr><th>Water consumption (litres/person/day)</th><th>Credits</th><th></th></tr>
<tr><td><120 l/p/day</td><td>1</td><td>Levels 1 &2</td></tr>
<tr><td><110 l/p/day</td><td>2</td><td></td></tr>
<tr><td><105 l/p/day</td><td>3</td><td>Levels 3 & 4</td></tr>
<tr><td><90 l/p/day</td><td>4</td><td></td></tr>
<tr><td><80 l/p/day</td><td>5</td><td>Levels 5 & 6</td></tr>
</table></td><td>5</td><td>3

(+1)</td><td>Developer</td><td>Has been assumed that the sanitary fitting will be installed to ensure a water consumption of 105l/person/day is not exceeded as this is a mandatory council requirements as well as a mandatory Code level 4 requirement

Water 1 calculations required

Additional credits can be targeted but would require greywater recycling or rainwater harvesting to be implemented</td></tr>
</table>

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Wat 2	**<u>External Water Use</u>** Where a correctly specified and sufficient sized system to collect rainwater for external/internal irrigation/use has been provided to a dwelling with a garden, patio or communal garden space (examples of such systems include rainwater butts and central rainwater collection systems) *Default Cases*: If no individual or communal garden spaces are specified or if only balconies are provided, the credit can be awarded by default	1	1	Architect + Developer	Has been assumed that either individual or a communal rainwater collection system will be installed (Must be noted that for some flat this credit can awarded by default)

4.3. Materials

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Mat 1	**<u>Environmental Impact of Materials</u>** **Pre-Requisite (ALL LEVELS):** Where at least three of the following five key elements of the building envelope achieve a rating of A+ to D in the 2008 version of The Green Guide: • Roof • External walls • Internal walls (including separating walls) • Upper and ground floors (including separating floors) • Windows Where the Code Mat 1 Calculator Tool is used to assess the number of credits awarded for the five key elements described above 1-15 credits available	15	8 (+2)	Architect	Has been assumed that at least 3 of the following 5 key elements of the building envelope achieve a rating of A+ to D in the 2008 version of the green guide. - Roof - External walls - Internal walls - Upper and ground floors - Windows It has also been assumed that a Mat 01 Proforma will be completed to provide evidence of compliance. Therefore an average of 8 credits have been targeted. This may change throughout construction and therefore there is the potential for extra credits.

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Mat 2	**Responsible Sourcing of Materials – Basic Building** Where 80% of the assessed materials in the following Building Elements are responsibly sourced: • Frame • Ground floor • Upper floors (including separating floors) • Roof • External walls • Internal walls (including separating walls) • Foundation/substructure (excluding sub-base materials) • Staircase Additionally, 100% of any timber in these elements must be legally sourced	6	0 (+2)	Architect	Not been targeted as can process heavy (especially at post construction) and requires meticulous admin, additionally materials credits are not heavily weighted so have least impact on score if not targeted To be confirmed by the development team as to whether should be targeted or not

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Mat 3	**Responsible Sourcing of Materials – Finishing Elements** Where 80% of the assessed materials in the following Finishing Elements are responsibly sourced: • Staircase • Windows • External & internal doors • Skirting • Panelling • Furniture • Fascias • Any other significant use Additionally, 100% of any timber in these elements must be legally sourced	3	0 (+1)	Architect	Same as above

4.4. Surface Water Run-Off

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Sur 1	**Management of Surface Water Run-Off from Developments** **Pre-requisite (ALL LEVELS):** SuDS Management Train should be used as a guide to achieve the following: • Peak Rate of Run-Off • Volume of Run-Off **Water Quality Criteria:** **One credit** can be awarded by ensuring there is no discharge from the developed site for rainfall depths up to 5 mm (see Calculation Procedures). **One credit** can be awarded by ensuring that the run-off from all hard surfaces shall receive an appropriate level of treatment in accordance with The SuDS Manual to minimise the risk of pollution.	2	2	Hydrologist	It has, first of all, been assumed that mandatory criteria will be achieved. Also been assumed that there will be no discharge from the developed site for rainfall depths up to 5mm and also that run-off from all hard surfaces will receive appropriate levels of treatment in accordance with SUDs Manual to minimise risk of pollution. To be confirmed by a suitably qualified hydrologist in a Sur 1 report.
Sur 2	**Flood Risk** 2 Credits available if the site can be shown to be in Zone 1 – low annual probability of flooding OR 1 credit is available for developments situated in Zones 2 or 3a – medium and high annual probability of flooding and mitigation requirements have been incorporated into the design	2	2	Hydrologist	By observing the Environment Agency's flood map it can be seen that the site of the proposed development is within flood zone 1 and is at a low risk of flooding. Therefore 2 credits can be targeted. To be confirmed by a suitably qualified hydrologist in a Sur 2 report post-planning.

4.5. Waste

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Was 1	**<u>Storage of Non-recyclable Waste and Recyclable Household Waste</u>** **Pre-requisite:** An adequate external space should be allocated for waste storage and sized to accommodate containers according to the largest of the following two volumes: • The minimum volume recommended by British Standard 5906 (British Standards Institution, 2005) based on a maximum collection frequency of once per week. This volume is 100 litres for a single bedroom dwelling, with a further 70 litres for each additional bedroom. • The total volume of the external waste containers provided by the Local Authority. Storage space must provide inclusive access and usability (Checklist IDP). Containers must not be stacked. **2 Credits: Storage of Recyclable Household Waste** Dedicated internal storage for recyclable household waste can be credited where there is no (or insufficient) dedicated external storage capacity for recyclable material, no Local Authority collection scheme and where the following criteria are met: At least three internal storage bins: • All located in an adequate internal space • With a minimum total capacity of 60 litres. **4 Credits: Storage of Recyclable Household Waste** Combination of internal storage capacity provided in an adequate internal space, with either: • a Local Authority collection scheme, or • No Local Authority collection scheme but adequate external storage capacity.	4	4	Architect + Developer	It can be seen on the Camden Council's website that there is weekly after collection sorting for household waste and mixed recycling. However it is also assumed that there will be a single bin with a capacity of at least 30 litres in an adequate internal space. Therefore all 4 credits are targeted. To be confirmed by the development team

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Was 2	**Construction Site Waste Management** **1st Credit: Minimising Construction Waste** Where there is a compliant Site Waste Management Plan (SWMP) that contains: a. Target benchmarks for resource efficiency, i.e. m3 of waste per 100 m2 or tonnes of waste per 100 m2 set in accordance with best practice b. Procedures and commitments to minimize non-hazardous construction waste at design stage. Specify waste minimisation actions relating to at least 3 waste groups and support them by appropriate monitoring of waste. c. Procedures for minimising hazardous waste d. Monitoring, measuring and reporting of hazardous and non-hazardous site waste production according to the defined waste groups (according to the waste streams generated by the scope of the works) **2nd & 3rd Credit: Diverting Waste from landfill** Where a complaint SWMP has been produced and the following have been achieved: • Where at least 50% by weight or by volume of non-hazardous construction waste generated by the project has been diverted from landfill • Where at least 85% by weight or by volume of non-hazardous construction waste generated by the project has been diverted from landfill.	3	3	Contractor	Has been assumed that 85% of site waste will be diverted from landfill by the development team therefore all 3 credits have been targeted Dependent of the contractor appointed To be confirmed by the development team

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Was 3	**<u>Composting</u>** Where one of the following has been provided: • Individual home composting facilities • Local communal or community composting service • Local Authority green/kitchen waste collection system	1	1	Developer	It can be seen from the Camden Council website that there is a food and garden waste collection scheme therefore this credit has been targeted. There still needs to be on-site bins: - In a dedicated position - Provide inclusive access and usability - Have a supporting information leaflet

4.6. Pollution

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment

<table>
<tr><th>Credit</th><th>Description</th><th>Credits Available</th><th>Credits Targeted</th><th>Responsible party</th><th>Comment</th></tr>
<tr><td>Pol 1</td><td><u>Global Warming Potential (GWP) of Insulants</u>

Credits are awarded where all insulating materials in the elements of the dwelling listed below only use substances that have a GWP < 5 (in manufacture AND installation):
Roofs: including loft access
Walls: internal and external including lintels and all acoustic insulation
Floors: including ground and upper floors
Hot water cylinder: pipe insulation and other thermal stores
Cold water storage tanks: where provided
External doors</td><td>1</td><td>1</td><td>Architect</td><td>It has been assumed that all insulants used will meet the necessary criteria to allow this credit to be targeted

To be confirmed by the development team</td></tr>
<tr><td>Pol 2</td><td><u>NO_x Emissions</u>

<table><tr><th>Dry NOx Level (mg/kWh)</th><th>Boiler Class</th><th>Credits</th></tr><tr><td><100</td><td>4</td><td>1</td></tr><tr><td>>70</td><td>5</td><td>2</td></tr><tr><td><40</td><td>-</td><td>3</td></tr><tr><td colspan="2">Default Case – if space heating and domestic hot water is provided by a system that does not produce NOx emissions</td><td>3</td></tr></table></td><td>3</td><td>2

(+1)</td><td>Mechanical Engineer</td><td>Has been assumed that if the proposed strategy in the ESR is implemented the boilers will produce >70mg/kWh NO_x

However if boilers are installed that produce equal to or less than 40mg/kWh NO_x then the third credit could be targeted

To be confirmed by the development team</td></tr>
</table>

4.7. Health and Well-being

<table>
<tr><th>Credit</th><th>Description</th><th>Credits Available</th><th>Credits Targeted</th><th>Responsible party</th><th>Comment</th></tr>
<tr><td>Hea 1</td><td><u>Daylighting</u>
One Credit: Kitchens must achieve a minimum Average Daylight Factor of at least 2%
One Credit: All living rooms, dining rooms and studies (including any room designated as a home office under Ene 9 – Home Office) must achieve a minimum Average Daylight Factor of at least 1.5%
One Credit: 80% of the working plane in each kitchen, living room, dining room and study (including any room designated as a home office under Ene 9 – Home Office) must receive direct light from the sky</td><td>3</td><td>3</td><td>Daylighting Consultant</td><td>It has been assumed that rooms will pass daylight calculations
To be confirmed by the daylight calculations</td></tr>
<tr><td>Hea 2</td><td><u>Sound Insulation</u>
<table>
<tr><th>Airbourne Sound Insulation Value</th><th>Impact Sound Insulation Value</th><th>Credit</th></tr>
<tr><td>>3dB</td><td>>3dB</td><td>1</td></tr>
<tr><td>>5dB</td><td>>5dB</td><td>3</td></tr>
<tr><td>>8dB</td><td>>8dB</td><td>4</td></tr>
<tr><td colspan="2">Default Case: Detached dwelling</td><td>4</td></tr>
<tr><td colspan="2">Default Case: Attached dwelling where separating walls or floors occur between non-habitable rooms</td><td>3</td></tr>
</table></td><td>4</td><td>3
(+1)</td><td>Architect
+
Acoustician</td><td>Has been assumed that sound insulation value will be >5dB so credits have been targeted
However 4 credits can be targeted but would require input from architect on achievability
Acoustic test required</td></tr>
</table>

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Hea 3	**Private Space** Where outdoor space (private or semi-private) has been provided that is: • Of a minimum size that allows all occupants to use the space. • Provided with inclusive access and usability (Checklist IDP). • Accessible only to occupants of designated dwellings.	1	0	Architect	Plans show that there is no communal outdoor space provided therefore this credit has not been targeted. However this would vary between flats as some have individual gardens and some have balconies which would allow the credit to be targeted.
Hea 4	**Lifetime Homes** All credits can be awarded where all Principles of Lifetime Homes have been complied with. Only 3 credits can be awarded where exemption from criteria 2 and/or 3 is applied	4	4	Architect	Assumed that all principles of lifetime homes will be met

4.8. Management

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Man 1	**Home User Guide** **2 Credits**: Provision of a Home User Guide, compiled in accordance with Checklist Man 1, Part 1, together with confirmation that the guide is available in alternative formats. **1 Credit:** Where the guide includes additional information relating to the site and its surroundings and is compiled in accordance with Checklist Man 1, Part 2.	2	3	Developer	Has been assumed that a home user guide will be compiled in accordance with checklist Man 1, Part 1 and Part 2 To be confirmed by the development team

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Man 2	**Considerate Constructors Scheme** **1 Credits**: Where there is a commitment to meet best practice under a nationally or locally recognised certification scheme such as the Considerate Constructors Scheme **2 Credit**: Where there is a commitment to go significantly beyond best practice under a nationally or locally recognised certification scheme such as the Considerate Constructors Scheme	2	1 (+1)	Contractor	Has been assumed that a score of between 25-34 will be achieved with a score of at least 5 in each section However 2nd credit can be awarded for a score between 35-50 with a score of at least 7 in each section Dependant on contractor appointed
Man 3	**Construction Site Impacts** **1 Credit:** Where there are procedures that cover two or more of the following items: Monitor, report and set targets for CO2 production or energy use arising from site activities Monitor and report CO2 or energy use arising from commercial transport to and from site Monitor, report and set targets for water consumption from site activities Adopt best practice policies in respect of air (dust) pollution arising from site activities Adopt best practice policies in respect of water (ground and surface) pollution occurring on the site 80% of site timber is reclaimed, re-used or responsibly sourced **2 Credits:** Where there are procedures that cover four or more of the items listed above.	2	2	Contractor	Has been assumed that procedures to Monitor, report and set targets for CO_2 production/ energy use from site activities and water consumption from site activities AND Adopt best practice policies for air pollution and water pollution To be confirmed by the development team

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Man 4	**<u>Security</u>** An Architectural Liaison Officer (ALO) or Crime Prevention Design Advisor (CPDA) from the local police force is consulted at the design stage and their recommendations are incorporated into the design of the dwelling. AND Section 2 – Physical Security from 'Secured by Design – New Homes' is complied with (Secured by Design certification is not required).	2	2	Security Consultant + Architect + Developer	Has been assumed that an Architectural Liaison Officer (ALO) or Crime Prevention Design Advisor (CPDA) will be consulted and Section 2 of secure by design will be complied with To be confirmed by the development team

4.9. Ecology

Credit	Description	Credits Available	Credits Targeted	Responsible party	Comment
Eco 1	**Ecological Value of Site** Where the development site is confirmed as land of inherently low ecological value EITHER By meeting the criteria for low ecological value (using Checklist Eco 1 – Land of Low Ecological Value under Checklists and Tables below) OR By being confirmed by a suitably qualified ecologist OR Where an independent ecological report of the site, prepared by a suitably qualified ecologist, confirms that the construction zone is of low or insignificant ecological value AND Any land of ecological value outside the construction zone but within the development site will remain undisturbed by the construction works.	1	1	Ecologist	Has been assumed that the land is of a low ecological value To be confirmed in ecology report
Eco 2	**Ecological Enhancement** Where a suitably qualified ecologist has been appointed to recommend appropriate ecological features that will positively enhance the ecology of the site. AND Where the developer adopts all key recommendations and 30% of additional recommendations.	1	1	Ecologist	Assumed that at least 30% of the ecologists recommendations will be implemented To be confirmed by an ecologist and by development team

<table>
<tr><th>Credit</th><th>Description</th><th>Credits Available</th><th>Credits Targeted</th><th>Responsible party</th><th>Comment</th></tr>
<tr><td>Eco 3</td><td><u>Protection of Ecological Features</u>

Where all existing features of ecological value on the development site potentially affected by the works are maintained and adequately protected during site clearance, preparation and construction works.

OR

Where the site has been classified as being of Low Ecological Value</td><td>1</td><td>1</td><td>Ecologist</td><td>Assumed that the land will be of low ecological value

To be confirmed in ecology report</td></tr>
<tr><td>Eco 4</td><td><u>Change in Ecological Value of the Site</u>

The ecological value before and after development is measured, and the overall change in species per hectare is:

1 Credit: Minor negative change: between –9 and less than or equal to –3

2 Credits: Neutral: greater than –3 and less than or equal to +3

3 Credits: Minor enhancement: greater than 3 and less than or equal to 9

4 Credits: Major enhancement: greater than +9</td><td>4</td><td>2</td><td>Ecologist</td><td>Assumed there will be a neutral change in the ecological value of site

To be confirmed in ecology report</td></tr>
<tr><td>Eco 5</td><td><u>Building Footprint</u>

Credits are awarded based on the net internal floor area: net internal ground floor area ratio

<table><tr><th>Houses</th><th>Flats</th><th>Combination</th><th>Credits</th></tr><tr><td>2.5:1</td><td>3:1</td><td rowspan="2">NIA:NIGA > area weighted target</td><td>1</td></tr><tr><td>3:1</td><td>4:1</td><td>2</td></tr></table></td><td>2</td><td>1</td><td>All</td><td>As per calculations:

The gross internal floor area = 640.31m²
The gross internal ground floor area = 197.4m²

Therefore achieving a ratio of 3.25:1 allowing 1 credit to be targeted</td></tr>
</table>