Sustainability and Energy Statement

70 Elsworthy Road, Primrose Hill

For Wolff Architects

July 2015

XCO2 energy

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About us:
XCO2 Energy are a low-carbon consultancy working in the built environment. We are a multi-disciplinary company consisting of engineers, environmental experts and architects, with specialists including CIBSE low carbon consultants, Code for Sustainable Homes, EcoHomes and BREEAM assessors and LEED accredited professionals.

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Executive Summary

This report outlines the sustainability and energy strategy for the proposed development at 70 Elsworthy Road in line with the requirements set out by the London Plan and the London Borough of Camden. The proposed development comprises a 1,970m^2 three storey dwelling and an outhouse/ garage located to the Northwest of Primrose Hill.

As per the recent review of the housing standards, the new build dwelling is not required to be assessed under Code for Sustainable Homes (CfSH). Nonetheless, the design team will incorporate environmental principles into the scheme to maximise its sustainability credentials.

This document is divided into three parts:

- Planning policies
- Sustainability elements incorporated into the scheme
- Energy Strategy

The first part provides an overview of the site, the Camden Council planning policies applicable to this development and the London Plan. The report then demonstrates how the policies have been met.

The second section outlines the sustainability measures that have been adopted in the team's aim to maximise the sustainability of the development.

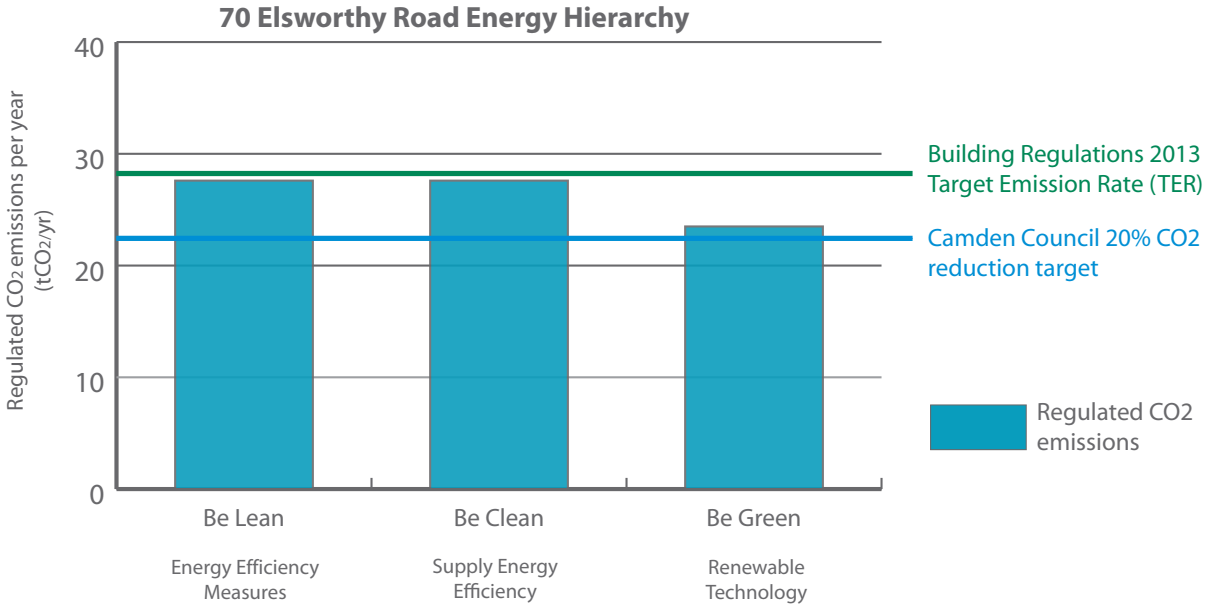
The third section describes the predicted energy performance and carbon dioxide emissions of the proposed development at 70 Elsworthy Road. The new build dwelling will be compared to a notional building constructed to Part L1A standards.

The diagram and the tables on the following page summarise the regulated CO_2 savings achieved by the proposed development in comparison to the baseline building at each stage of the energy hierarchy. In total, the development is expected to achieve regulated CO_2 savings of 15.7%. This reduction reflects regulated energy use only, as unregulated energy use (e.g. plug-in appliances) is not taken into account in Part L of the Building Regulations.

The regulated CO_2 saving has been achieved by maximising fabric efficiency first. The team aims to improve the building fabric significantly beyond the Building Regulations Part L Baseline through the incorporation of an efficient fabric with low U values, a good air permeability rate and a thermal bridging y-value in line with the Accredited Construction Details. Further to this, the scheme will include the maximum feasible number of PV panels on the roof to attain further carbon emissions reductions.

The 15.7% reduction in regulated CO_2 emissions exceeds the Part L1A CO_2 reduction targets set out in Building Regulations. This falls short of the 20% reduction target outlined on the Sustainability Statement page of the Camden Council website. However, CO_2 reductions have been maximised on site through the provision of an enhanced building fabric surpassing Building Regulation targets, and a large photovoltaic array.

Subsequently, a 15.7% reduction is a notable achievement for a minor development of this nature, and demonstrates the client and design team's commitment in adopting a range of sustainability measures for the life-cycle of the development.



CO_2 Emissions Breakdown

	Carbon Dioxide emissions (tonnes CO_2 per annum)		
	Regulated	Unregulated	Total
Baseline building	27.9	9.0	36.9
After energy demand reduction (Lean)	27.6	9.0	36.5
After CHP (Clean)	27.6	9.0	36.5
After PV (Green)	23.5	9.0	32.5

	Carbon dioxide savings (tonnes CO_2 per annum)		Carbon dioxide savings from baseline (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	0.3	0.3	1.2%	0.9%
Savings from CHP	0.0	0.0	0.0%	0.0%
Savings from PV	4.0	4.0	14.5%	11.0%
Cumulative savings	4.4	4.4	15.7%	11.9%

Site

The proposed development at 70 Elsworthy Road comprises of the construction of a large seven bedroom main dwelling, a two bedroom outhouse/ garage and an extensive basement connecting the two.

The main dwelling consists of a three storey, seven bedroom dwelling with an internal area of 1,970m^2. The scheme is situated in a low-rise, urban location near to the junction between Elsworthy Road and Avenue Road, with Primrose Hill to the Southeast and Swiss Cottage School to the immediate Northwest of the site boundary.

The site is located within the confines of the London Borough of Camden.

The approximate site location is shown in the figure below.

Approximate site location at 70 Elsworthy Road

Planning Policies

The development has been designed in line with the requirements set out by the London Borough of Camden as well as the London Plan 2015.

The relevant planning policies for sustainability detailed in the current section are:

- Camden Core Strategy (2010)
- Camden Development Policies (DPD) (2010)
- Camden Plannning Guidance (CPG3) (2013)
- The London Plan (2015)

Camden Core Strategy 2010

The Camden Core Strategy sets out the Council's key planning policies and is a central part of their Local Development Framework (LDF). The recommendations for the sustainability policy is inserted below:

CS13 – Tackling climate change through promoting higher environmental standards

Reducing the effects of and adapting to climate change

The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation by:

a) Ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;

b) Promoting the efficient use of land and buildings;

c) Minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:

1. *Ensuring developments use less energy,*
2. *Making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralised energy networks;*
3. *Generating renewable energy on-site; and*

d) Ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

The Council will have regard to the cost of installing measures to tackle climate change as well as the cumulative future costs of delaying reductions in carbon dioxide emissions

Local energy generation

The Council will promote local energy generation and networks by:

e) Working with our partners and developers to implement local energy networks in the parts of Camden most likely to support them, i.e. in the vicinity of:

- *housing estates with community heating or the potential for community heating and other uses with large heating loads;*
- *the growth areas of King's Cross; Euston; Tottenham Court Road; West Hampstead Interchange and Holborn;*
- *schools to be redeveloped as part of Building Schools for the Future programme;*
- *existing or approved combined heat and power/ local energy networks;*

and other locations where land ownership would facilitate their implementation.

f) protecting existing local energy networks where possible (e.g. at Gower Street and Bloomsbury) and safeguarding potential network routes (e.g. Euston Road);

Water and surface water flooding

We will make Camden a water efficient borough and minimise the potential for surface water flooding by:

g) protecting our existing drinking water and foul water infrastructure, including Barrow Hill Reservoir, Hampstead Heath Reservoir, Highgate Reservoir and Kidderpore Reservoir;

h) making sure development incorporates efficient water and foul water infrastructure;

i) requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and downstream flooding, especially in areas up-hill from, and in, areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross.

Camden Development Policies 2010

In addition to the Core Strategy Document the Camden Development Policies also forms part of the LDF. The policy relating to sustainability is listed below:

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:

c) expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016.;

d) expecting developments (except new build) of 500 sq m of residential floorspace or above or 5 or more dwellings to achieve "very good" in EcoHomes assessments prior to 2013 and encouraging "excellent" from 2013;

e) expecting non-domestic developments of 500sqm of floorspace or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.

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

DP6 – Lifetime homes

Lifetime homes standards will be applied to all developments of self-contained housing, including conversions, re-configurations and changes of use.

Camden Planning Guidance - Sustainability CPG3 - 2013

The Camden Planning Guidance support the policies set out in the Local Development Framework (LDF). While the Camden LDF contains policies relating to sustainability in their Core Strategy and Development Policies documents, the Council also has a separate planning guidance specific to sustainability.

The sections that will be covered by a combination of the Sustainability Statement and accompanying Energy Statement are listed below:

- The energy hierarchy
- Energy efficiency: new buildings
- Decentralised energy networks and combined heat and power
- Renewable Energy
- Water Efficiency
- Sustainable use of materials
- Sustainability assessment tools
- Brown roofs, green roofs and green walls
- Flooding
- Adapting to climate change
- Biodiversity

Camden Sustainability Statements - design and construction -2015

In light of the housing standards review in March of this year, Camden Council has clarified its position on the sustainability considerations that have to be taken into account for new developments.

Water

New residential development will be required to demonstrate that the development is capable of achieving a maximum internal water use of 105 litres per person/day, with an additional 5 litres person/day for external water use.

Energy

The Council will continue to apply policies which require compliance with energy performance standards until the Planning and Energy Act 2008 has been amended (likely late 2016). The Code Level 4 equivalent in carbon dioxide emissions reduction below part L Building Regulations 2013 is 20%. New residential dwellings will be required to demonstrate how this has been met by following the energy hierarchy in an energy statement.

The London Plan 2015

The London Plan March 2015 (further alterations to the London Plan) requires compliance with the following policies relating to climate change:

Policy 5.2 Minimising Carbon Dioxide Emissions
(refer to the supplementary Energy Report)

- *Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:*
  1 Be lean: use less energy
  2 Be clean: supply energy efficiently
  3 Be green: use renewable energy

- *The Mayor will work with boroughs and developers to ensure that major developments meet a 40% carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.*

- Policy 5.3 Sustainable Design and Construction
- Policy 5.5 Decentralised Energy Networks
- Policy 5.6 Decentralised Energy in Development Proposals
- Policy 5.7 Renewable Energy
- Policy 5.12 Flood Risk Management
- Policy 5.13 Sustainable Drainage
- Policy 5.15 Water use and Supplies
- Policy 5.18 Construction, Excavation and Demolition Waste

The proposed dwelling at 70 Elsworthy Road does not qualify as a major development. However, the design team have endeavoured to reduce CO_2 emissions as far as practically possible on site through the use of an energy efficient building fabric, construction and materials, as well as renewable energy via the inclusion of PV panels. As such, the development has achieved the council targets required.

The following sections set out how Camden Council's Core Strategy, Development Policies, Planning Guidance, and the London Plan will be met by the proposed development at 70 Elsworthy Road, through the implementation of energy efficiency and sustainability measures.

Housing Standards Review

The government announced the conclusion to the Housing Standards Review on 27 March 2015. The review aimed to simplify government regulations and standards into one key set, driven by building regulations.

As an outcome from the Deregulation Bill (2015) the written ministerial statement withdrew the Code for Sustainable Homes (in England) so Local Authorities will no longer require it as a planning condition for new approvals, nor will local authorities be able to enforce it. Where there are existing contractual arrangements, for example with Registered Social Landlords under the Affordable Funding Programme 2015-2018, it is possible to continue to register and certify against the Code.

One outcome from the review is dual level building regulations (Access and Water), which will give local authorities some choice to require developers to build to different standards than the minimum requirements. Furthermore, with appropriate evidence, local authorities can also use the new space standards which make up the new national technical standards. There will also be a new mandatory building regulation for security. The building regulations will be come into play as of October 2015.

The new dual level Building Regulations have come about because of clauses within the Deregulation Act. The Act also brings in a Clause which amends the Planning and Energy Act 2008 to prevent local authorities from requiring higher levels of energy efficiency than building regulations. This second clause has yet to be commenced, and the written ministerial statement sets out how this will be implemented in 2016. Local Authorities in England will no longer be able to require levels of the Code for Sustainable Homes.

In light of outcome of the Housing Standards review, the proposed development will endeavour to implement sustainability measures as much as possible, without formal implementation of the Code for Sustainable Homes Assessment and Certification at post planning stage.

Sustainability measures overview

The ensuing subsections detail the sustainability measures that will be incorporated into the design.

Energy efficiency

The proposed dwelling at 70 Elsworthy Road will meet current Building Regulations 2013 Part L1A compliance through a combination of passive and active building design measures.

Passive design

The passive design strategies that will be incorporated into the scheme follow some of the principles of PassivHaus design, which is one of the most robust building design standards.

The strategies include low U-values for all opaque building elements ranging from 0.10-0.20 W/m^2.K. This indicates an improvement beyond the Building Regulations U value targets which require 0.30 W/m^2.K for walls, 0.25 W/m^2.K for floors and 0.20 W/m^2.K for roofs. The majority of the design U values also exceed the PassivHaus standard requirement of 0.15 W/m^2.K for all elements, which means that the development aims to achieve the best building fabric that is feasibly possible.

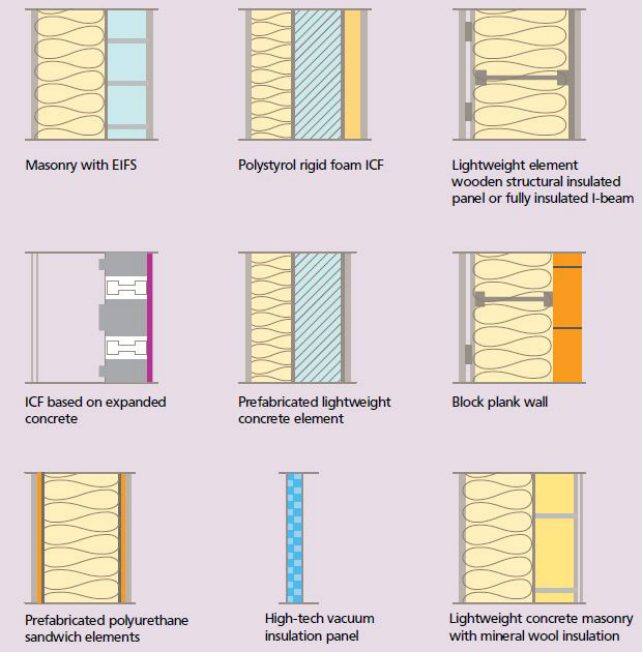
Additionally, the development will incorporate an air permeability of 5m^3/hm^2, which goes notably beyond Building Regulations. On this basis, the development aims to go significantly beyond current guidance requirements on envelope limiting performance standards.

Further to the above, the proposed development will aim to achieve a thermal bridging y-value of 0.08 in line with the Accredited Construction details for all junctions, which will further improve thermal comfort within the spaces of the dwelling and reduce heating energy consumption.

These passive design principles will also help maintain the Fabric Energy Efficiency, measured in kWh/m^2.annum, at minimum levels.

In addition, carefully sized glazing areas will help achieve satisfactory levels of daylight and minimise the need for artificial lighting during daytime.

These measures are in accordance with the CPG3 - Chapter 3: Energy Efficiency: new buildings.



Examples of high insulation wall constructions

Windows will also be openable to provide natural ventilation to all habitable spaces at above ground levels. The design will incorporate wind driven natural ventilation strategies as shown in the images below. This will enable higher ventilation rates to be achieved in summer to dissipate the heat gains.

Active design

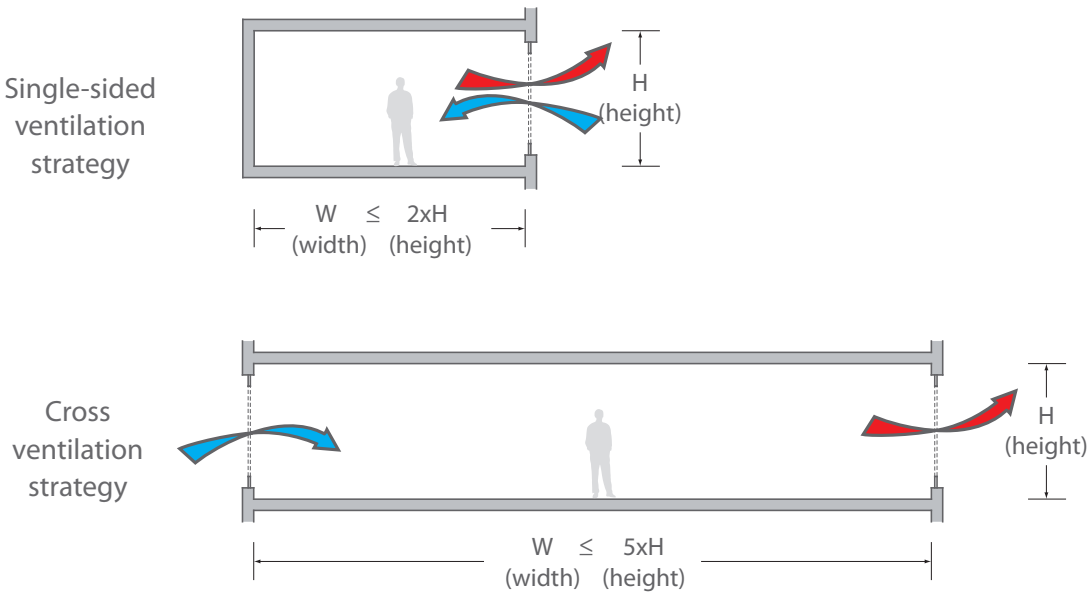
In terms of building services, the building will be provided with high efficiency heating and hot water systems, as well as low energy lighting to further reduce energy use. The basement level will be ventilated by a high efficiency mechanical ventilation system with heat recovery.

Energy efficiency will be considered in unregulated energy items, including any external lighting at the terraces as well as equipment such as dishwashers, washing machines, fridges etc which will be of contemporary performance standards.

Materials

Embodied energy is the energy that is used in the manufacture, processing and the transportation of the materials to site. Where practicable, materials with a high recycled or waste content will be specified for the construction of the proposed dwelling.

All timber used during site preparation and construction to be FSC certified, and all non-timber materials to be certified with Environmental Management Systems (ISO 14001 OR BES 6001) where possible. The development will aim for at 10% of the total value of materials used to be derived from recycled and reused sources as per the CPG3 - Chapter 8: Sustainable use of materials.



Natural ventilation principles that will be adopted

Surface water

The development is located in a low flood risk zone as shown in the map below (green mark) and will not entail any additional flood risks to the local area.

Environmental Agency flood map. Site location shown in green.

Water efficiency

The development will strive to limit water consumption through the use of water efficient fittings and appliances, such as:

- dual flush toilets,
- low flow taps and showers, and
- efficient washing machines and dishwashers.

These measures will ensure that water consumption at the new dwelling will not exceed the limit of 105 litres per person per day, which meets the requirements of Camden Council outlined on the Sustainability Statement web page.

Recommended specification for sanitary fittings:

Fitting	Consumption per Use
WC (full flush)	6 litres per flush
WC (half flush)	3 litres per flush
Kitchen sink tap	6 litres per min
Wash basin tap	4 litres per min
Bath	180 litres to overflow
Shower	8 litres/min
Washing machine	8.17 litres/kilogram
Dishwasher	1.25 litres/place setting

Water butts will be provided to collect rainwater for the irrigation of the landscaped areas and gardens in line with the CPG3 - Chapter 7: Water efficiency.

Ecology

Local biodiversity will be maintained through landscaping of the surrounding private garden space. Native plant species will be introduced to these areas where possible.

Waste

The development will minimise the impact of construction waste on the environment through developing and implementing waste management targets in line with best practice benchmarks where appropriate. The construction team will aim to minimise waste to landfill where possible.

Health and well-being

The dwelling has been designed to ensure all internal spaces will receive good levels of daylight through the provision of large glazing areas. The generous private outdoor garden space provided will enhance the occupants' wellbeing.

Energy Strategy Summary

This section describes the predicted energy performance and carbon dioxide emissions of the proposed 70 Elsworthy Road development based on the information provided by the design team.

Methodology - Be Lean, Be Clean, Be Green
The methodology used to determine CO_2 emissions is in accordance with the London Plan's three-step Energy Hierarchy (Policy 5.2A) outlined below. The dwelling will be compared to a Building Regulations Part L 2013 baseline.

The table on the following page shows the savings made at each stage of the energy hierarchy. The reductions made through each step have been outlined here:

1. Be Lean - use less energy
In accordance with this strategy, this development will incorporate a range of energy efficiency measures including energy efficient lighting, high performance glazing and levels of insulation beyond building regulation requirements.

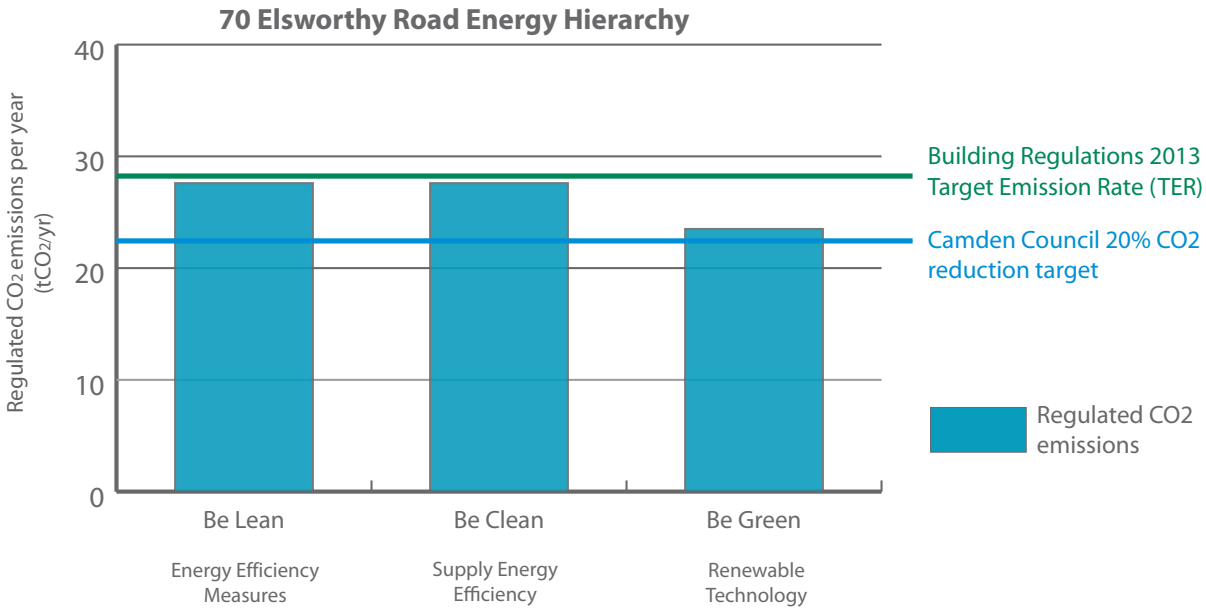
Overall, the incorporation of these measures will help the building reduce the energy demand of the building and subsequently the CO_2 emissions. The implementation of these measures will reduce regulated CO_2 emissions by 1.2% when compared to the baseline building.

2. Be Clean - supply energy efficiently
The second strategy takes into account the efficient supply of energy, by prioritising decentralised energy generation. The feasibility study showed that no district heating networks currently exist within close proximity of the site and a small scale CHP would not be suitable for the single dwelling development at 70 Elsworthy Road. Therefore, it is proposed that high efficiency individual gas boilers will be used as the main source of heating and hot water for the main dwelling and the outhouse.

3. Be Green - use renewable energy
The feasibility study analysed a number of renewable technologies for their suitability for the site. The analysis included a biomass heating system, ground-source heat pumps, air-source heat pumps, photovoltaics, solar thermal and wind turbines. The majority of these technologies were deemed unsuitable for the project due to site limitations.

The analysis demonstrated that photovoltaics were the most suitable renewable technology. The installation of 54.2m^2 of photovoltaics with a rated output of 10.3 kWp would potentially reduce regulated CO_2 emissions by 14.5% from the baseline building. Given the amount of roof space available and the constraints of the site, the installation of photovoltaics would be the most suitable renewable strategy for this development.

Overall, the total cumulative reduction in regulated and unregulated carbon emissions is expected to be 11.9%, whilst the reduction in regulated emissions alone will be 15.7%. The potential for CO_2 reductions have been maximised as far as possible for this proposal, in line with GLA and the London Borough of Camden's Policies. The resulting savings is a significant achievement for a development of this scale and nature.



CO_2 Emissions

The table below lists the regulated and unregulated carbon dioxide emissions for the baseline scheme and the emissions once the lean, clean and green measures have been implemented.

The figures show a CO_2 reduction in regulated emissions amounting to 15.7%, when compared to the Building Regulations Part L 2013 baseline for a new build dwelling.

CO_2 Emissions Breakdown

	Carbon Dioxide emissions (tonnes CO_2 per annum)		
	Regulated	Unregulated	Total
Baseline building	27.9	9.0	36.9
After energy demand reduction (Lean)	27.6	9.0	36.5
After CHP (Clean)	27.6	9.0	36.5
After PV (Green)	23.5	9.0	32.5

	Carbon dioxide savings (tonnes CO_2 per annum)		Carbon dioxide savings from baseline (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	0.3	0.3	1.2%	0.9%
Savings from CHP	0.0	0.0	0.0%	0.0%
Savings from PV	4.0	4.0	14.5%	11.0%
Cumulative savings	4.4	4.4	15.7%	11.9%

Demand Reduction (Be Lean)

Passive Design Measures

Enhanced Building Fabric

The heat loss of different building elements is dependent upon their U-value. A building with low U-values provides better levels of insulation and a reduced heating demand during the cooler months.

The development will incorporate high levels of insulation and high-performance double glazing on all of the facades to significantly reduce the demand for space heating (refer to the table below). In addition, the construction detailing of all junctions will aim to be in line with Accredited Construction Details in order to achieve a thermal bridging y-value of 0.08.

U-Values - New Build Dwelling (W/m²K)

Element	Part L1A Building Regs	Proposed	Improve-ment
Walls	0.30	0.15	50%
Floors	0.25	0.10	60%
Roof	0.20	0.10	50%
Windows	2.0	1.3	35%

Air Tightness

Heat loss may also occur due to air infiltration. Although this cannot be eliminated altogether, good construction detailing and the use of best practice construction techniques can minimise the amount of air infiltration.

Part L Building Regulations (2013) sets a maximum air permeability rate of $10m^3/m^2$ at 50Pa. The proposed development is likely to improve upon this to achieve at least $5m^3/m^2$ at 50Pa.

Daylighting

The development has been designed to improve daylighting in all habitable spaces, as a way of improving the health and wellbeing of its occupants.

Natural Ventilation

The possibility of natural ventilation strategies will reduce the likelihood of overheating in summer months.

Active Design Measures

High Efficacy Lighting

The development intends to incorporate low energy lighting fittings throughout the building. All light fittings will be specified as low energy lighting, and will accommodate LED, compact fluorescents (CFLs) or fluorescent luminaries only.

Heating and Cooling Infrastructure (Be Clean)

Energy System Hierarchy

The energy system for the development has been selected after reviewing the London Plan decentralised energy hierarchy. The hierarchy listed in Policy 5.6 states that energy systems should be specified in the following order:

1. Connection to existing heating and cooling networks
2. Site wide CHP network
3. Communal heating and cooling

Local supply of heat and power minimises distribution losses, achieving a greater efficiency than installing separate systems and thus, reducing CO_2 emissions.

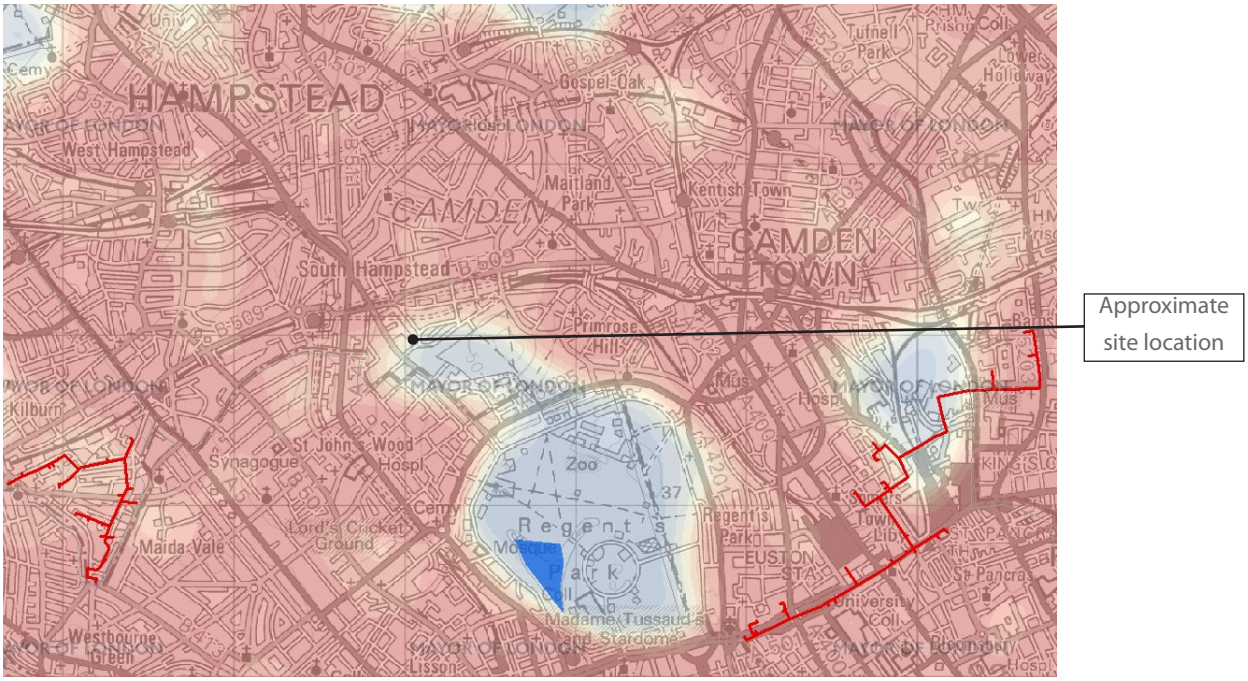
In a communal energy system, energy in the form of heat, cooling, and/or electricity is generated from a central source and distributed via a network to surrounding residencies and commercial units.

Connection to Existing Low Carbon Heat Distribution Networks

The London Heat Map identifies existing and potential opportunities for decentralised energy projects in London. It builds on the 2005 London Community Heating Development Study. An excerpt from the London Heat Map below shows the energy demand for different areas. Darker shades of red signify areas where energy demand is high. The map also highlights any existing and proposed district heating systems within the vicinity of the development. There are no CHP plants and heat networks in close proximity of the site.

Most Appropriate System for the Proposed Dwelling

The most efficient system for the production of hot water for domestic hot water and space heating for the proposed dwelling would be to install high efficiency gas boilers. This will provide the occupants with a flexible and controlled method of space and water heating.



London Heat Map - There are no existing CHP plants and heat networks in close proximity to the site.

Renewable Energy (Be Green)

Once the energy demand has been minimised, methods of generating low and zero carbon energy can be assessed. The renewable technologies to be considered for the development are:

- Biomass
- Photovoltaic panels
- Solar thermal panels
- Ground/water source heat pumps
- Air source heat pump
- Wind energy

The table below summarises the factors taken into account in determining the appropriate renewable technology for this project. This includes estimated lifetime, level of maintenance, and level of impact on external appearance. The final column indicates the feasibility of the technology in relation to the site conditions (10 being the most feasible and 0 being infeasible).

The feasibility study concludes that photovoltaic panels are the most feasible option for the site. Details of the proposed PV array are presented on the following pages.

70 Elsworthy Road

		Comments	Lifetime	Maintenance	Impact on External Appearance	Site Feasibility
Biomass		Not adopted -burning of wood pellets releases high NOx emissions and there are limitations for their storage and delivery within an urban location.	20yrs	High	High	1
PV		Adopted Technology	25yrs	Low	Med	9
Solar Thermal		Not adopted -solar thermal array would require additional plumbing, space for hot water storage and would conflict with the space requirements of the photovoltaic array.	25yrs	Low	Med	3
GSHP		Not adopted -the installation of ground loops require significant space, additional time at the beginning of the construction process and very high capital costs.	20yrs	Med	Low	1
ASHP		Not adopted -ASHP evaporator units are located externally and produce noise which can be an issue in a residential location, especially at night.	20yrs	Med	Med	3
Wind		Not adopted -wind turbines would achieve low CO_2 savings in this site due to space limitations. In addition, they would have a significant visual impact on the neighbourhood.	25yrs	Med	High	1

Photovoltaic Panels

Four types of solar cells are available on the market at present and these are mono-crystalline, poly-crystalline, thin film and hybrid panels. Although mono-crystalline and hybrid cells are the most expensive, they are also the most efficient with an efficiency rate of 12-20%. Poly-crystalline cells are cheaper but they are less efficient (9-15%). Thin film cells are only 5-8% efficient but can be produced as thin and flexible sheets.

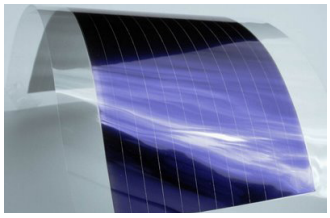
Photovoltaics are considered to be a suitable technology for this development for the following reasons:

- There is sufficient roof space available to install enough PV modules to have a significant impact on carbon dioxide emissions of the development.
- The installation of photovoltaics is much simpler when compared to other renewable technologies
- Photovoltaics sited on the roof within an urban area are less visually intrusive when compared to wind turbines

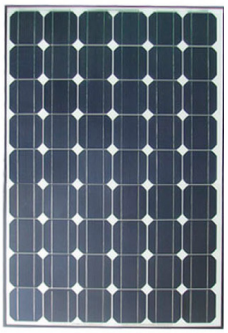
A 54.2 m^2 array of 19% efficiency PV modules on the dwelling, with a rated output of 10.3 kWp, would offset 14.5% of regulated CO_2 emissions from the Part L notional baseline.

Photovoltaic Panels		
Module Efficiency	19	%
Orientation	Horizontal	
Predicted site solar energy	945	kWh/ m^2/yr
System losses	20	%
System peak power	10.3	kWp
Array area	54.2	m^2
Primary electricity offset by PV array	7,790	kWh/ yr
Total CO_2 savings	4.0	t/yr
Notional Building regulated CO_2 emissions	27.6	t/yr
Notional Building total CO_2 emissions	36.5	t/yr
Regulated CO_2 reduction from clean stage	14.7	%
Total CO_2 reduction from clean stage	11.1	%
Regulated CO_2 reduction from Baseline	14.5	%
Total CO_2 reduction from clean Baseline	11.0	%

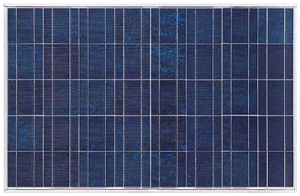
A hybrid PV Panel



Thin film PV



A monocrystalline PV Panel



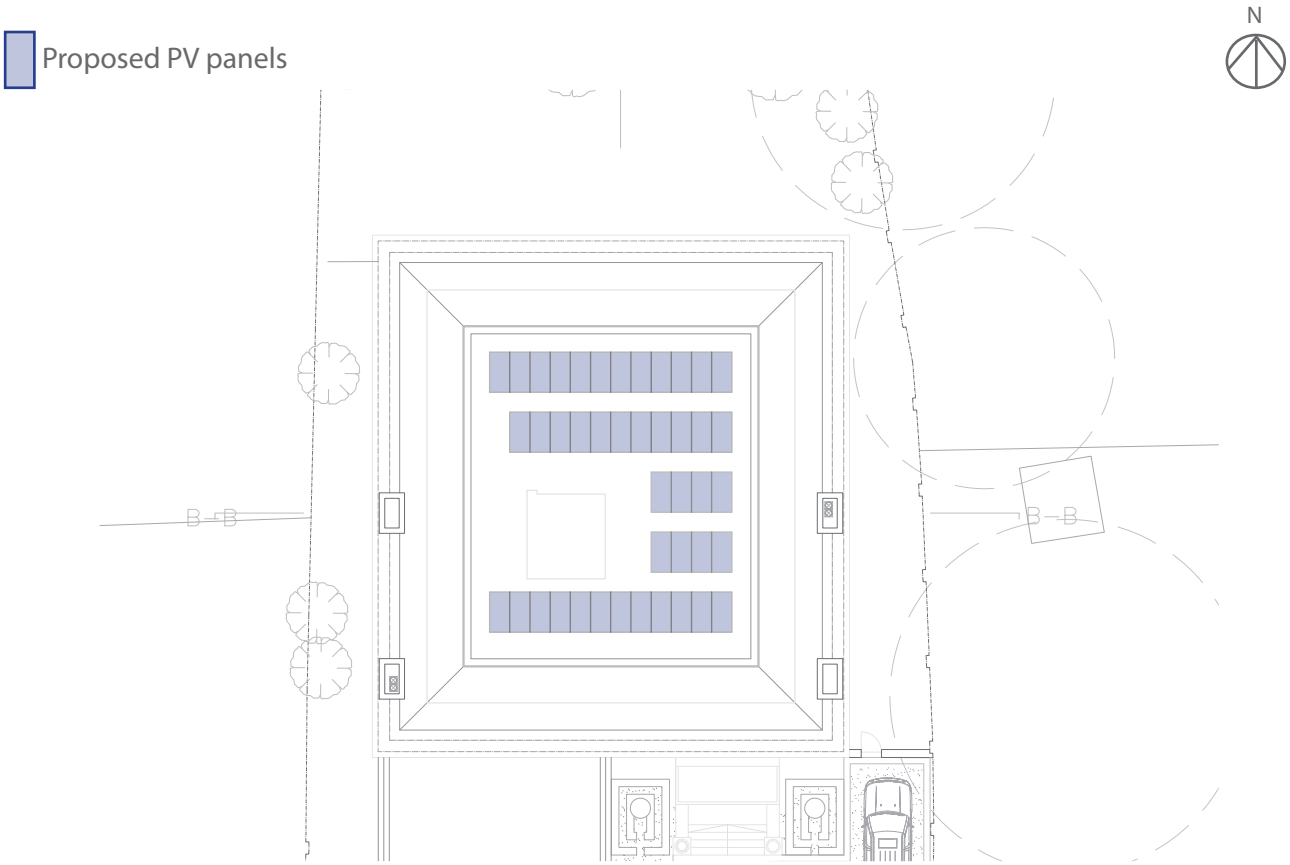
A polycrystalline PV Panel

Location of Photovoltaic Panels

An appropriate location for the proposed photovoltaic panels was identified once the site constraints were taken into account. The factors taken into considerations included:

- Avoiding any potential overshadowing from adjacent PV panels;
- Space required for maintenance including all health and safety requirements for roof access;
- Minimising any potential glare and the possibility of being overlooked by the occupants; and
- The location of any amenity spaces.

The PV arrays have been placed on the flat roof and horizontally mounted to minimise visibility of the panels from street level. An indicative PV layout is presented in the figure below.



Roof plan for 70 Elsworthy Road showing roof mounted PV panels