Energy Statement

92 Fitzjohn's Avenue, Hampstead

For MAKE

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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 both architects and engineers, 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 assesses the predicted energy performance and carbon dioxide emissions of the proposed single dwelling at 92 Fitzjohn's Avenue based on the information provided by the design team. The proposal includes the construction of a single dwelling located to the east of Fitzjohn's Avenue in Hampstead within the London Borough of Camden.

The methodology used to determine the CO_2 emissions is in accordance with the London Plan's three-step Energy Hierarchy (Policy 5.2A) outlined below:

1. Be Lean - use less energy
The first step deals with the reduction in energy use, through the adoption of sustainable design and construction measures.

In accordance with this strategy, this development will incorporate a range of energy efficiency measures including levels of insulation in excess of Building Regulation requirements, the installation of high performance glazing and low energy lighting. The improvements in the building fabric have reduced regulated CO_2 emissions by 24.8%

2. Be Clean - supply energy efficiently
The second strategy takes into account the efficient supply of energy, by prioritising decentralised energy generation.

To introduce cleaner production of hot water and space heating, CHP and communal heating were considered for this project. The development of an independent dwelling deems both of these options to be unsuitable. A high efficiency gas boiler will be used to supply space heating and hot water for the dwelling.

3. Be Green - use renewable energy
The third strategy covers the use of renewable technologies.

A feasibility study was carried out for this development and a range of renewable technologies were analysed. The analysis included a biomass heating system, ground-source heat pumps, air-source heat pumps, photovoltaics (PV), solar thermal and wind turbines.

The analysis demonstrated that a combination of PV and solar thermal panels would be the most suitable renewable strategy for this development. The implementation of this system would potentially reduce regulated CO_2 emissions by a further 46.2% over the clean strategy.

Conclusion

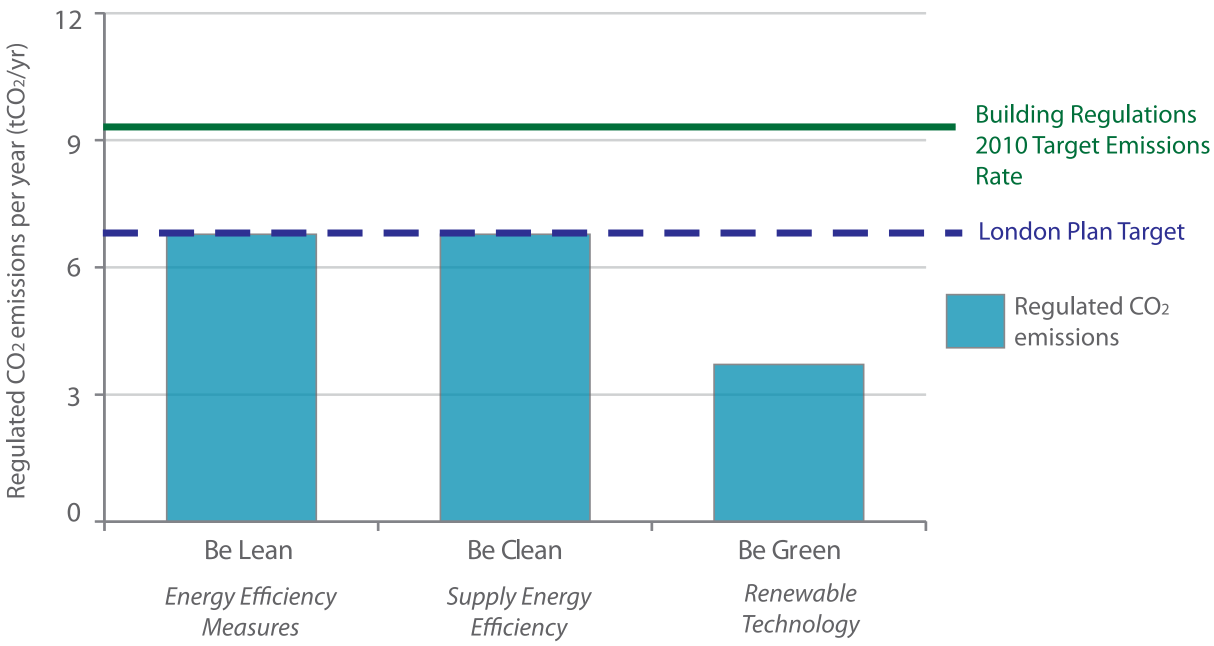
The graph on the following page provides a summary of the CO_2 emissions at each stage of the London Plan Energy Hierarchy.

It can be seen on the graph that the development exceeds Building Regulations compliance and London Plan targets (although not required for a development of this size) through energy efficiency measures and renewable strategies.

The proposed renewable systems are estimated to reduce total (regulated + unregulated) CO_2 emissions by 29.3%, which significantly exceed the requirement of 20% CO_2 reduction from on-site renewables required by Camden Council.

In total, the development is expected to reduce regulated CO_2 emissions by 59.5% when compared with a notional building built to current Part L Building Regulations (2010), which is a large reduction for a single dwelling development.

The London Plan Energy Hierarchy



Carbon Dioxide Emissions After Each Stage of the Energy Hierarchy

	Carbon dioxide emissions (tonnes CO_2 per annum)	
	Regulated	Unregulated
Building Regulations 2010 Part L Compliant Development	9.1	3.9
After energy demand reduction	6.8	3.9
After clean measures	6.8	3.9
After renewables	3.7	3.9

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	2.2	24.8%
Savings from CHP	0.0	0.0%
Savings from renewable energy	3.1	46.2%
Total Cumulative Savings	5.4	59.5%

Introduction

The proposed development at 92 Fitzjohn's Avenue includes a single dwelling to be located east of Fitzjohn's Avenue, adjacent to Henderson Court Resource Centre and St. Anthony's Preparatory School in Hampstead, within the London Borough of Camden.

It should be noted that an Energy Statement is not compulsory, given the size of the proposed development. However, it is of the clients' wishes to fully present the sustainability credentials of the scheme.

The habitable area of the proposed dwellings is distributed over two storeys, with the main living areas at entrance floor level and bedroom accommodations planned for both floors. The development will replace an existing residential building and car parking on site.

This document discusses the expected energy performance of the development and explains the inclusions and design features that will reduce the energy use and arising CO_2 emissions of the development. These include energy efficiency measures, communal heating systems and low carbon technologies. This is in line with the London Borough of Camden.

The Camden Core Strategy (November 2010) requires Code for Sustainable Homes Level 4, with 50% of the unweighted credits in the Energy and Water categories (Development Policy DP22, Camden Planning Guidance paragraphs 3.22 and 9.8). Please refer to the supplementary Sustainability Report on how this standard has been met.

This report refers to how the development addresses the energy policies of section 5 of the London Plan, including:

- Policy 5.2 Minimising Carbon Dioxide Emissions
- 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 where feasible.

In particular, this report details how an attempt has been made to achieve the following CO_2 reduction targets:

- 25% reduction in CO_2 emissions (London Plan 2011, Policy 5.2)
- 20% reduction in total CO_2 emissions by renewables (Camden Core Strategy, as suggested in paragraph 13.11)

It should be noted that the London plan does not require developments of less than 10 dwellings to meet a 25% reduction in CO_2 emissions.

The methodology employed to determine the potential CO_2 savings for this development, is in accordance with the three step Energy Hierarchy outlined in the London Plan:

- Be Lean - Improve the energy efficiency of the scheme
- Be Clean - Supply as much of the remaining energy requirement with low-carbon technologies such as combined heat and power (CHP)
- Be Green - Offset a proportion of the remaining carbon dioxide emissions by using renewable technologies.

Demand Reduction (Be Lean)

Passive Design Measures

Enhanced Building Fabric

The heat loss of different building elements is dependent upon their U-value. The lower the U-value, the better the level of insulation of a particular element. A building with low U-values has a reduced heating demand during the cooler months.

The dwelling at 92 Fitzjohn's Avenue will incorporate high levels of insulation and high efficiency glazing in order to reduce the demand for space heating (see table below).

U-Values (W/m²K)

Element	Building Regulations	Proposed	Improve-ment
Walls	0.30	0.15	50%
Roof	0.20	0.12	40%
Basement floor	0.25	0.12	52%
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 into a building.

Current Part L Building Regulations (2010) sets a maximum air permeability rate of $10m^3/m^2$ at 50Pa. The development is likely to improve upon this to achieve $5m^3/m^2$ at 50Pa through the application of best practice construction techniques.

Orientation & Site Layout

The dwellings have been designed to benefit from passive solar gains. Floor-to-ceiling windows have been incorporated on the southeast elevation for the main habitable rooms to benefit from passive solar gains, and to reduce the need for space heating.

Thermal Bridging

The dwellings will also reduce heat loss through minimising thermal bridging. This will be achieved by following Accredited Construction Details or designing specifically to reduce the thermal bridging y-value down to less than 0.08 W/m²K.

Lighting

Daylight has been considered and maximised in the design of the building on site, especially in the habitable rooms of the dwelling. Appropriately positioned large windows will be used to improve the health and well-being of occupants.

Natural Ventilation

Natural ventilation with the possibility of cross ventilation and stack ventilation will reduce the likelihood of overheating in summer months. Please see the Sustainability Statement for further details on the above.

Active Design Measures

High Efficacy Lighting

The development intends to incorporate low energy light fittings. 100% of all light fittings will be specified as low energy lighting, and will accommodate compact fluorescent (CFLs), fluorescent luminaries or LEDs where possible.

Energy Demand

The table below shows a breakdown of the energy consumption and carbon dioxide emissions associated with the building's heating and electricity demand. The figures provide a comparison between the baseline condition and the proposed development once energy efficiency measures (Lean) have been taken into account. The breakdown shows the CO_2 savings made to the hot water, space heating, cooling, auxiliary and lighting demand once the energy efficiency measures have been incorporated into the building fabric.

Breakdown of Energy Consumption and CO_2 Emissions

	Part L 2010 Baseline		Lean		
	CO_2 emissions ($kgCO_2$/year)	CO_2 ($kgCO_2/m^2$)	Energy (kWh/year)	CO_2 emissions ($kgCO_2$/year)	CO_2 ($kgCO_2/m^2$)
Hot Water	436	0.8	2,439	483	0.9
Space Heating	8,089	15.3	29,231	5,788	10.9
Cooling	0	0.0	0	0	0.0
Auxiliary	41	0.1	116	60	0.1
Lighting	495	0.9	938	485	0.9
Equipment (excluded from Part L)	3,912	7.4	7,568	3,912	7.4
Total Part L	9,060	17.1	32,725	6,816	12.9
Total (inc Equip)	12,973	24.5	40,292	10,728	20.3

CO_2 Emissions

The table below shows the regulated and unregulated carbon dioxide emissions for the baseline scheme and the emissions after the passive and active lean measures have been implemented. It can be seen that a 24.8% reduction in regulated CO_2 emissions has been made at this stage of the energy hierarchy.

CO_2 Emissions Breakdown

	Carbon Dioxide emissions (tonnes CO_2 per annum)		
	Regulated	Unregulated	Total
Baseline building	9.1	3.9	13.0
After energy demand reduction	6.8	3.9	10.7

	Carbon dioxide savings (tonnes CO_2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	2.2	2.2	24.8%	17.3%

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 in line with the flowchart given within the Camden Planning Guidance.

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

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.

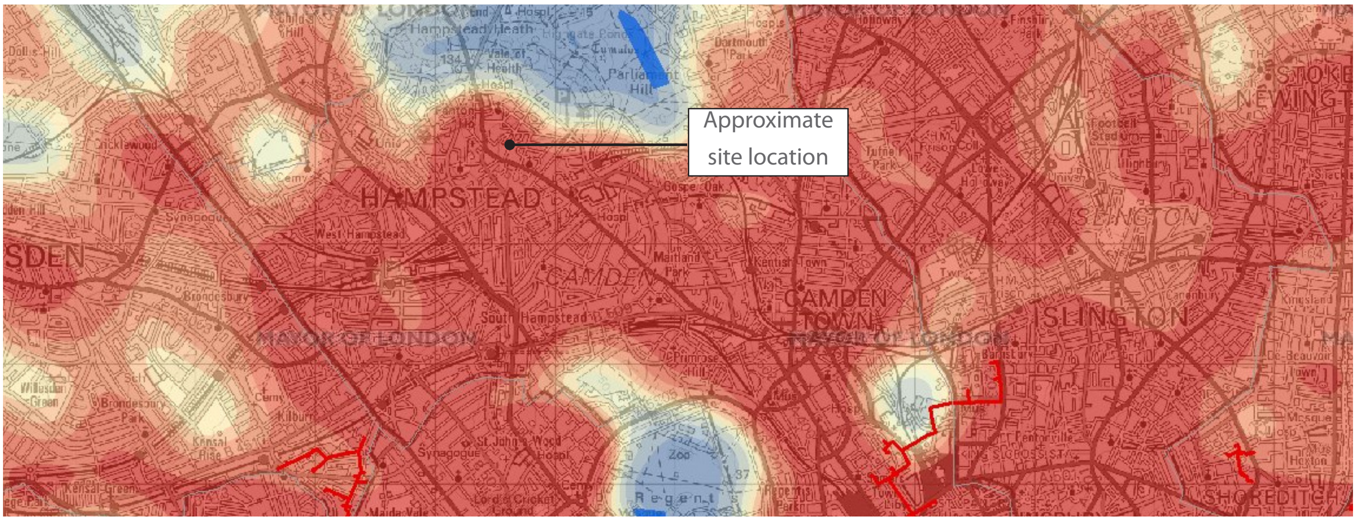
Connection to Existing Low Carbon Heat Distribution Networks

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 the area surrounding the site. Darker shades of red signify areas where heat demand is high and lighter colours where heat demand is low. The map indicates that there are no existing or proposed networks near to the development.

Feasibility of Installing Decentralised Heat and Power

Due to the low energy demand on site a communal heat network would not be feasible for this development. The size of the dwellings and the energy loads may mean that a micro-CHP maybe suitable. However, micro CHPs are a relatively new technology and are currently an unproven way of reducing CO_2 emissions. They are an expensive and high maintenance solution for the small amount of electricity they generate in return. We would suggest that a larger portion of energy and CO_2 can be saved through the installation of other renewable technologies. A high efficiency gas boiler will be installed to meet the space heating and hot water demands of the dwelling.



London Heat Map image of areas surrounding the development

CO_2 Emissions

The table below shows the regulated and unregulated carbon dioxide emissions for the baseline scheme as well as the reduced emissions once Lean (energy efficiency) and Clean (CHP) measures have been implemented. The tables below illustrate that regulated CO_2 savings are expected to be an additional 0% over Lean measures, as CHP will not be adopted as part of the energy strategy for the development.

CO_2 Emissions Breakdown

	Carbon Dioxide emissions (tonnes CO_2 per annum)		
	Regulated	Unregulated	Total
Baseline building	9.1	3.9	13.0
After energy demand reduction (Lean)	6.8	3.9	10.7
After CHP (Clean)	6.8	3.9	10.7

	Carbon dioxide savings (tonnes CO_2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	2.2	2.2	24.8%	17.3%
Savings from CHP	0.0	0.0	0.0%	0.0%

Renewable Energy (Be Green)

Once energy demand reductions have 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

In order to determine the feasibility of the above technologies, their suitability for the site and compatibility with the measures already implemented through the Lean step has been appraised. The technologies deemed suitable will be assessed in more detail.

The potential energy and carbon savings achievable from incorporation of each of the above renewable technologies were estimated for the proposed dwelling at Fitzjohn's Avenue using the Stroma SAP software.

It should be noted that the total savings from a combination of renewable strategies is unlikely to be identical to the sum of savings from implementation of individual renewables due to the calculation methodology adopted by the SAP software.

Where possible, the final system has been sized to meet a 20% CO_2 reduction in line with Camden Council's aspirations (Paragraph 13.11 under Policy CS13 of the Camden Core Strategy).

The following section presents the potential savings and feasibility for the renewable technologies considered.






Photovoltaic Panels- Adopted

Four types of solar cells available at present are mono-crystalline, poly-crystalline, thin film and hybrid. Although mono-crystalline and hybrid cells are the most expensive, they are the most efficient (12-20%). Poly-crystalline cells are cheaper but they are less efficient (9-15%). Thin film cells are only 5-8% efficient but have the advantage of being produced as thin and flexible sheets.

In this development, a roof level space dedicated for installation of photovoltaic or solar thermal arrays have been incorporated into the design of the building. The panels will be laid horizontally to maximise available roof space without self-shading issues.

The feasibility study for 92 Fitzjohn's Avenue showed that photovoltaics to be one of the most suitable renewable technology for the following reasons:

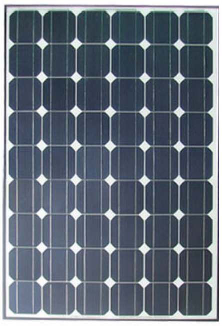
- There is sufficient roof space available to install enough PV modules to have a significant impact on carbon dioxide emissions of the development;
- The installation of photovoltaics is much simpler when compared to other renewable technologies;
- photovoltaics sited on the roof are less visually instrusive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

A total of 49m^2 of 15% efficiency PV modules (7.2kWp), would produce a total CO_2 saving of 22.0% and a regulated saving of 34.7% after the lean and clean measures have been implemented.

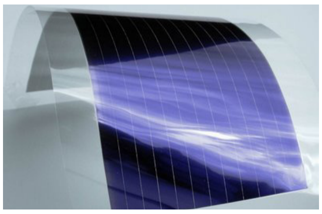
This technology will be implemented as part of the 'Be Green' strategy at 92 Fitzjohn's Avenue. A roof plan illustrating the proposed location of the PV array on the roof of 92 Fitzjohn's Avenue is presented in Page 13.

Photovoltaic Panels		
Module Efficiency	15	%
Orientation	Horizontal	
Predicted site solar energy	961	kWh/m^2/yr
System losses	20	%
System peak power	7.2	kWp
Array area	49	m^2
Primary electricity offset by PV array	5,535	kWh/yr
Total CO_2 savings	2.4	t/yr
Regulated Clean CO_2 emissions	6.8	t/yr
Total Clean CO_2 emissions	10.7	t/yr
% Regulated CO_2 reduction	34.7	%
% Total CO_2 reduction	22.0	%

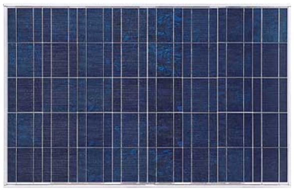
A hybrid PV Panel



A monocrystalline PV Panel



Thin film PV



A polycrystalline PV Panel

Solar Thermal- Adopted

Solar thermal arrays include evacuated tubes and flat plate collectors. Evacuated tubes are more efficient, produce higher temperatures and are more suited to the UK climate in general when compared to flat plate collectors.

Solar thermal arrays have similar requirements as PV arrays. The panels will be orientated towards the southeast in line with the proposed roof design.

For this development solar thermal would be used for domestic hot water heating. The use of solar thermal for space heating would not be practical as it is not required when solar thermal operation is at its most effective during the summer months.

A suitable solar thermal system would supply approximately 63% of the annual hot water consumption (the maximum feasible due to seasonal variations). Calculations show that a 4m^2 solar thermal array would reduce regulated CO_2 emissions by 2.5%.

This technology will be implemented as part of the 'Be Green' strategy at 92 Fitzjohn's Avenue. The proposed location of the solar thermal array is shown in the roof plan in the following page.

Solar Thermal		
Collector Type	Evacuated Tube	
System Efficiency	40	%
Orientation	Horizontal	
Predicted site solar energy	913	kWh/m^2/yr
Solar fraction	56	%
Total collector area	4	m^2
Primary gas energy offset by Solar Thermal system	1,708	kWh/yr
Total CO_2 savings	0.2	t/yr
Regulated Clean CO_2 emissions	6.8	t/yr
Total Clean CO_2 emissions	10.7	t/yr
% Regulated CO_2 reduction	2.5	%
% Total CO_2 reduction	1.6	%

An evacuated tube panel

Proposed Roof Plan

A roof plan showing proposed locations of the PV and solar thermal array is presented below.

Proposed roof plan with PV and solar thermal arrays

Biomass Heating- Not Adopted

A biomass system designed for this development would be fuelled by wood pellets which have a high energy content. Wood pellets require less volume of storage than other biomass fuels. Pellet boilers also require less maintenance and produce considerably less ash residue.

A biomass boiler could supply 100% of the space heating and supplement hot water demand to the proposed dwelling. This would be equivalent to a regulated CO_2 savings of 78.2%.

A biomass system is considered not to be the preferred solution for the development given the amount of plant space required for pellet storage. The scheme aims to minimise the building footprint, and the erection of external structures for biomass storage (either pellets or locally sourced chips) would be undesirable. There will also be concerns over local air quality and the increase in NOx emissions as a result of burning wood as fuel.

Example of wood pellet fuel

Example of pellet boiler and pellet storage room.
Source: Energy Crops Limited

Biomass		
% of heating load supplied by biomass	100	%
Biomass System Efficiency	90	%
Carbon Intensity of Biomass	0.028	$kgCO_2$/kWh
Backup System Efficiency	90	%
Carbon Intensity of Backup	0.198	$kgCO_2$/kWh
Heating Demand Met	28,503	kWh/yr
Total CO_2 savings	5.3	t/yr
Regulated Clean CO_2 emissions	6.8	t/yr
Total Clean CO_2 emissions	10.7	t/yr
% Regulated CO_2 reduction	78.2	%
% Total CO_2 reduction	49.7	%

Ground Source Heat Pumps- Not Adopted

Due to the building footprint occupying the majority of the site, a ground source heat pump system for the proposed dwelling would include a series of ground boreholes where a liquid (water or refrigerant) passes through the system, absorbing heat from the ground and relaying this heat via an electrically run heat pump within the building.

A ground source heat pump system would deliver space heating through a low temperature efficient distribution network such as underfloor heating.

A GSHP system sized to meet 100% of space heating demand can achieve a total of 13.4% reduction in the development's regulated CO_2 emissions. Initial calculations indicate that 5-8 no. 100m deep boreholes will be suitable to meet the space heating demand and top up hot water usage.

However, the borehole system is not considered financially feasible for the proposed development due to the high capital cost involved and therefore not implemented. A combination of PV and solar thermal arrays will offer significantly larger energy savings, and therefore deemed to be the more suitable renewable strategy for the development in comparison to a GSHP system.

GSHP		
COP Heat	3.0	
Carbon Intensity of Electricity	0.517	$kgCO_2$/kWh
Proportion of Space Heating met by GSHP	100	%
Proportion of Hot Water met by GSHP	25	%
Energy met by GSHP	26,857	kWh/yr
Energy used by GSHP	8,952	kWh/yr
Total CO_2 savings	0.9	t/yr
Regulated Clean CO_2 emissions	6.8	t/yr
Total Clean CO_2 emissions	10.7	t/yr
% Regulated CO_2 reduction	13.4	%
% Total CO_2 reduction	8.5	%

Example of GSHP borehole pipework.

Air Source Heat Pumps- Not adopted

Air source heat pumps (ASHPs) employ the same technology as ground source heat pump (GSHPs). However, instead of using heat exchangers buried in the ground, heat is extracted from the external ambient air.

A benefit of ASHP is that the system produces space heating and hot water through electricity, thereby negating the need for a gas connection to the dwelling.

The efficiency of heat pumps is very much dependent on the temperature difference between the heat source and the space required to be heated. As a result ASHPs tend to have a lower COP than GSHPs. This is due to the varying levels of air temperature throughout the year when compared to the relatively stable ground temperature. The lower the difference between internal and external air temperature, the more efficient the system.

ASHP		
COP Heat	2.5	
Carbon Intensity of Electricity	0.517	kgCO_2/ kWh
Proportion of Space Heating met by ASHP	90	%
Proportion of Hot Water met by ASHP	25	%
Energy met by ASHP	24,226	kWh/yr
Energy used by ASHP	9,690	kWh/yr
Total CO_2 savings	0.2	t/yr
Regulated Clean CO_2 emissions	6.8	t/yr
Total Clean CO_2 emissions	10.7	t/yr
% Regulated CO_2 reduction	3.4	%
% Total CO_2 reduction	2.1	%

The use of ASHPs as a low carbon technology for this development would result in a regulated CO_2 savings of 3.4%.

In addition, the following issues may be of concern:

- ASHP evaporators would need to be located externally. Any noise associated with the units could potentially be an issue due to the proximity of the neighbouring buildings
- Issues of noise may also be of concern at night, as the development is mainly residential

For these reasons, ASHP was not considered to be a feasible renewable technology for the site.

ASHP external unit

Wind Turbines- Not adopted

Due to the limited availability of space on site, building-integrated turbines would be required for the site, as opposed to stand alone turbines.

CO_2 savings from wind turbine technologies take into account their mounting height, the turbine wind curve and wind data. This information was obtained from the BERR website and used in the Carbon Trust Wind Yield Estimation Tool. The average annual wind speed at a mounting height of 10m above the building canopy is estimated to be 5.0 m/s. In reality, however, due to local obstructions, wind speeds are expected to be significantly lower than that.

Due to the spacing required between wind turbines, one turbine could be sited on the roof. The two tables below outline 2 options for two different wind turbines, a 2.5kW and 6kW mounted on the roof.

The results show that the regulated CO_2 savings for each option are 12.3% and 30.9% for the 2.5kW and 6kW turbines respectively.

Due to the visual impact of wind turbines and site obstructions, which are likely to greatly reduce the calculated outputs, photovoltaics are expected to be a more feasible option for on site electricity generation on the proposed dwelling than wind.

A building-mounted 6kW Proven wind turbine

Wind Power - 2.5kW		
Average wind speed assumed	3.5	m/s
Number of Turbines	1	
Electricity offset by turbine	1,584	kWh/yr
Carbon intensity of offset electricity	0.529	$kgCO_2$/kWh
Total CO_2 savings	0.8	t/yr
Regulated Clean CO_2 emissions	6.8	t/yr
Total Clean CO_2 emissions	10.7	t/yr
% Regulated CO_2 reduction	12.3	%
% Total CO_2 reduction	7.8	%

Wind Power - 6kW		
Average wind speed assumed	3.5	m/s
Number of Turbines	1	
Electricity offset by turbine	3,987	kWh/yr
Carbon intensity of offset electricity	0.529	$kgCO_2$/kWh
Total CO_2 savings	2.1	t/yr
Regulated Clean CO_2 emissions	6.8	t/yr
Total Clean CO_2 emissions	10.7	t/yr
% Regulated CO_2 reduction	30.9	%
% Total CO_2 reduction	19.7	%

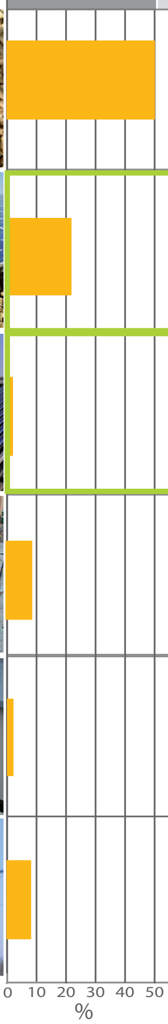
Renewable Energy Summary

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).

Renewable Energy Conclusions

Results from the feasibility study shows that a combination of PV and solar thermal arrays would be the most feasible low or zero carbon energy strategy for the proposed dwelling at 92 Fitzjohn's Avenue. Therefore, these two technologies will be implemented at the proposed dwelling as part of the 'Be Green' strategy.

92 Fitzjohn's Avenue



	% Total CO_2 Reduced	Tonnes CO_2 per year	Lifetime	Maintenance	Impact on External Appearance	Site Feasibility	
Biomass		5.3	20yrs	High	High	3	
PV		2.4	25yrs	Low	Med	9	Adopted technology
Solar Thermal		0.2	25yrs	Low	Med	9	Adopted technology
GSHP		0.9	20yrs	Med	Low	5	
ASHP		0.2	20yrs	Med	Med	4	
Wind		0.8	25yrs	Med	High	2	

CO_2 Emissions

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

It can be seen that, compared to the clean stage a 46.2% reduction in has been made from the regulated emissions and a 29.3% reduction has been achieved on the total (regulated + unregulated) carbon dioxide emissions of the development.

CO_2 Emissions Breakdown

	Carbon Dioxide emissions (tonnes CO_2 per annum)		
	Regulated	Unregulated	Total
Baseline building	9.1	3.9	13.0
After energy demand reduction	6.8	3.9	10.7
After energy efficient supply	6.8	3.9	10.7
After renewables	3.7	3.9	7.6

	Carbon dioxide savings (tonnes CO_2 per annum)		Carbon dioxide savings (%)	
	Regulated	Total	Regulated	Total
Savings from energy demand reduction	2.2	2.2	24.8%	17.3%
Savings from energy efficient supply	0.0	0.0	0.0%	0.0%
Savings from renewable energy	3.1	3.1	46.2%	29.3%
Total Cumulative Savings	5.4	5.4	59.5%	41.6%

Conclusion

The regulated CO_2 emissions for the proposed dwelling at 92 Fitzjohn's Avenue have been reduced by 59.5%, once energy efficiency measures and renewables are taken into account. This far exceeds the 25% target set out in the London Plan 2011, although it is not a requirement for a project of this size.

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

1. Be Lean - use less energy

In accordance with this strategy, this development will incorporate a range of energy efficiency measures including efficient lighting, levels of insulation beyond building regulation requirements and the installation of high performance glazing. The regulated carbon emission savings from this stage are 24.8%, when compared to a notional building built to current Part L Building Regulations (2010).

2. Be Clean - supply energy efficiently

The feasibility study showed that no district heating networks currently exist within close proximity of the site. It would not be feasible at this point in time to include a micro CHP. A high efficiency gas boiler will be installed to supply space heating and hot water for the dwelling.

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 analysis demonstrated that a combination of PV and solar thermal arrays would be the most suitable renewable technology for this development. The installation of a 49m^2 PV array and a 4m^2 solar thermal array would potentially reduce regulated CO_2 emissions by a further 46.2%.

Including the unregulated CO_2, the proposed renewables strategy offers a 29.3% reduction in CO_2 emissions, which satisfies Camden Council's aspiration of 20% reduction by renewables.

Regulated Carbon Dioxide Savings From Each Stage of the Energy Hierarchy

	Regulated CO_2 Savings		Total CO_2 Savings
	Tonnes CO_2 per annum	%	%
Savings from energy demand reduction	2.2	24.8%	17.3%
Savings from CHP	0.0	0.0%	0.0%
Savings from renewable energy	3.1	46.2%	29.3%
Total Cumulative Savings	5.4	59.5%	41.6%