100 Park Village East, London NW1

Energy Strategy Report

Project Ref: 16793/005

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1 Introduction

1.1 Purpose of the Report

The purpose of this Energy Strategy Report is to indicate how the development at 100 Park Village East, Camden will respond appropriately to the energy policies of National government, Regional bodies (Greater London Authority) and Local Planning Authority (Camden Borough Council) and provide up to 10% of the site's energy demand through the incorporation of on-site renewable energy technologies.

1.2 Policy Drivers for Energy Efficiency and Renewable Energy

1.2.1 National policy – UK Government

The Government published "Climate Change – The UK Programme 2006" stating the Government's ongoing commitment to reducing the UK's contribution to climate change.

Under the Kyoto protocol the UK is committed to a reduction in greenhouse gas emissions by 2012 of 12.5% from 1990 levels. The UK government has further committed to a greater level of carbon dioxide reduction of 20% from 1990 levels by 2010 with this increasing to 60% by 2050. As part of this policy the Government have a target to provide 10% of electricity from renewable energy sources by 2010.

In January 2002, a Government Economic Service working paper 'Estimating the Social Cost of Carbon Emissions' was published as a joint DEFRA-Treasury publication. The GES paper suggested £70/tC (within a range of £35 to £140/tC) as an illustrative estimate for the global damage cost of carbon emissions.

Planning Policy Guidance or Statement notes (PPGs or PPSs) set out the Government's national land use planning policies for England. Two of these notes, PPS 1 'Delivering Sustainable Development' and PPS 22 'Renewable Energy', are particularly relevant to the promotion of renewables.

Promotion of renewables in PPS1 'Delivering Sustainable Development' is covered by the following statement: "Development plan policies should seek to minimise the need to consume new resources over the lifetime of the development by making more efficient use or reuse of existing resources, rather than making new demands on the environment; and should seek to promote and encourage, rather than restrict the use of renewable resources (for example, by the development of renewable energy)."

Planning Policy Statement (PPS) 22 'Renewable Energy', published in August 2004 gives guidance on the various types of renewable energy sources and how planning authorities should include requirements for renewable energy in their plans. A summary can be found in the London Renewables Toolkit.

Around 46% of energy usage in the UK is in buildings, including domestic, commercial and industrial use

1.2.2 Regional policy – Grater London Authority

The Mayor of London has committed to UK Government objectives by publishing the "Green Light for Clean Power" Policy document in March 2004. This provides additional detail to the London Plan published in February 2004 as a replacement to the previous Strategic Planning Guidance for London.

The London Plan aims to ensure London becomes an "exemplary, sustainable world city" whilst allowing London to grow in a responsible and considered socio-economic manner.

According to the Energy Strategy, buildings in London are responsible for 80% of the carbon emissions, with the remaining 20% due to transport. Building energy use reduction is therefore seen as the primary method to reduce emissions in London.

The Mayor of London's Energy Strategy details an energy hierarchy, which should be adopted on all new developments:

- Be lean Reduce energy consumption
- Be green Supply energy from on-site renewables
- Be clean Supply energy from efficient sources

In addition to this, the LDA have developed a London Renewables Toolkit, which summarises the requirements of the Energy Strategy and is aimed at providing advice to planners, developers and consultants on how to incorporate renewable energy into developments within London.

The London Plan includes targets to reduce CO_2 emissions at a regional level. Specifically a reduction of 20% in CO_2 emissions from 1990 levels is targeted by 2010.

The London Plan includes the following separate policies on energy.

Policy 4A.8 Energy assessment

The Mayor will and boroughs should request an assessment of the energy demand of proposed major developments, which should also demonstrate the steps taken to apply the Mayor's energy hierarchy.

Additionally the London Plan states:

Policy 4A.9 Providing for renewable energy

The Mayor will and boroughs should require major developments to show how the development would generate a proportion of the site's electricity or heat needs from renewables, wherever feasible.

Policy 4A.10 Supporting the provision of renewable energy

The Mayor will support and encourage the development of at least one large wind power scheme in London together with building mounted schemes, where they do not adversely affect the character and amenity of the area. UDP policies should identify suitable sites for wind turbines and other renewable energy provision, such as non-building integrated solar technologies along transport routes, reflecting the broad criteria to be developed by the Mayor in partnership with the Environment Agency and Boroughs.

Further, the Mayor's Energy Strategy proposal 13 requires that applications referable to him "generate at least ten per cent of the site's energy needs (power and heat) from renewable energy on the site where feasible".

1.2.3 Emerging Regional Policy – Greater London Authority

In accordance with the Mayor’s desire for London to be an “exemplary, sustainable world city”, the Mayor is increasing the onus on new developments to reduce their CO_2 emissions by integration of on site renewable energy. This is reflected generally in the Mayor’s Draft Further Alterations to the London Plan and specifically in *Policy 4A.7 Renewable Energy* of this which sates, “The Mayor will and boroughs in their DPD’s should require developments to achieve a reduction in their carbon dioxide emissions of 20% from onsite renewable energy.”

1.2.4 Local Planning Authority policy – Camden Council

The current Camden Unitary Development Plan (UDP) was adopted in June 2006. The parts of the UDP relating to Energy are listed below:

Policy SD9C - Use of energy and resources - The Council will seek developments that conserve energy and resources through:

a) Designs for energy efficiency;
b) Renewable energy use;
c) Optimising energy supply; and
d) The use of recycled and renewable building materials.

The Council will require major developments to demonstrate the energy demand of their proposals and how they would generate a proportion of the site’s electricity and heating needs from renewables wherever feasible.

Sub clause 1.64 expands this policy by stating “the council expects major developments of 1000 m^2 or 10 housing units or more to incorporate renewable energy production equipment to provide at least 10% of predicted energy requirements.”

Policy 3.19 - Consideration should be given to the use of sustainable energy systems including renewable energy and natural ventilation. Major developments are expected to incorporate renewable energy equipment. (See policy SD9C). The ‘Camden Green Buildings Guide’ contains further detail on developing sustainable buildings.

Camden Council’s Climate Change Action Plan 2006-9 states – we will adopt a Sustainable Design and Construction Policy. We will require promoters of major developments to consider the provision of 10% of their energy requirements through renewable energy.

1.3 The Proposed Development

100 Park Village East is a new residential development being proposed by Notting Hill Developments Limited on the Western side of the London Borough of Camden.

Located between Regents Park and Mornington Crescent underground station, the 10 storey building will have 41 apartments with a mix of rent, shared ownership and owned occupancy with a gross internal floor area of 2,324m^2.

2 Energy Assessment

2.1 Overview

Preliminary Standard Assessment Procedures (SAP) have been undertaken for the development in line with SAP 2005. In order to predict its energy usage and carbon footprint, where the glazing of the flats has not been determined, it is assumed to be 25% of the dwelling floor area as stipulated in Appendix R of SAP 2005.

2.2 Carbon Emissions

For a carbon mitigation strategy to be formulated it is necessary to understand the baseline CO_2 emissions before the integration of renewable energy. These have been calculated for the development as above and equate to 136.4 tonnes per annum. The table below shows the emissions reductions necessary to satisfy policy requirements, and the amount of electricity or heat that must be supplied by renewable technologies to achieve this. It is assumed that the use of electricity is associated with the emission of 0.43 $kgCO_2/kWh$ and that for gas this figure is 0.19 $kgCO_2/kWh$.

Total CO_2 (tonnes)	136.4
10% CO_2 (tonnes)	**13.6**
10% CO_2 electricity equivalent (MWh)	31.6
10% CO_2 gas equivalent (MWh)	71.6

2.3 Space Heating and Hot Water Demands

Additionally the SAP calculations have highlighted the space heating and hot water demands for the development. These are given below:

Energy Type	Energy Demand/ MWh/year
Space Heating	132.6
Hot Water	152.6
Total	**285.2**

3 Approach

3.1 Approach to energy in design

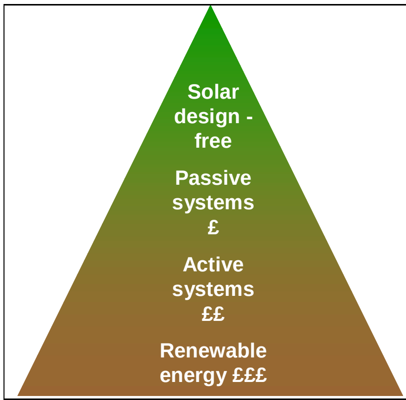

Figure 1 - Carbon reduction hierarchy

Peter Brett Associates believe in a holistic approach to carbon mitigation based on a hierarchy where the most effective measures used to reduce carbon emissions are those that cost the least:

- Solar design includes the correct orientation and form of a building in relation to its environment.

- Passive systems include an emphasis on the use of natural ventilation, effective solar shading and daylighting to obviate the need for active systems.

- Where active systems are required their design should minimise energy consumption while still performing to the required standard. Examples include utilising heat recovery in air handling units, using lighting controls based on occupancy with automated daylighting controls.

- Renewable systems should be considered in the context of the building and can be used to further reduced carbon emissions once cost effective options for reducing energy consumption have been implemented.

- If renewable systems can not be used effectively or prove to be too costly the remaining carbon emissions associated with energy supplied from carbon intensive sources should be mitigated by ensuring the most efficient use is made of these sources. An example of this is providing on-site combined heat and power generation or the distribution of electricity at the highest voltage practical where it must be distributed over longer distances.

3.2 Mayor's Energy Hierarchy

The Mayor's Energy Strategy – Green Light for Clean Power emphasises the same approach as that taken by Peter Brett Associates. This approach utilises a hierarchy which is summarised as follows:

- Be lean: Reduce energy consumption
- Be green: Supply energy from on-site renewables
- Be clean: Supply energy from efficient sources

3.3 Energy Strategy structure

The sections of the report that follow are structured in a manner suggested by the London Renewables Toolkit and cover the elements of the Mayor's Energy Hierarchy outlined above including an options appraisal for on-site renewable energy sources.

4 Reducing energy consumption

4.1 Overview

This section sets out the energy efficiency measures proposed as part of the design of each section of the development.

The thermal performance of the building envelopes is key in the overall design approach for the development. Particular emphasis is given to improvements in the ‘U’ values of the various elements, the utilisation of solar gain in the winter season and the air tightness in the building to reduce heat losses. This approach addresses the first issue given in the Mayor’s Energy Hierarchy – passive techniques to reduce energy consumption.

4.2 The Development

The provision of a high performance façade will reduce carbon emissions arising from space heating. This option will be investigated as part of the detailed design. The apartments will be built to a high standard based on attaining the revised 2006 Part L of the building regulations as a minimum. Options for including a higher performance fabric will be investigated in-line with national and local policies on reducing fuel poverty.

Individual metering will be provided to all individual units. Options for the provision of on-display metering will also be considered where it is felt this might increase awareness of energy efficiency and influence behaviour.

The need for electric lighting will be minimised by ensuring good access to daylight for all living spaces. Low energy light fittings will be used where appropriate.

The introduction of a community heating system will deliver further efficiency improvement but eliminating many smaller boilers all operating at different efficiencies according to their loading.

Any domestic white good appliances purchased by the developer will have an energy label rating of A and high efficiency lamps will be installed in all common part areas. Any luminaries installed in the apartments by the developer will be of compact mini fluorescent type. Lighting installed in areas of periodic occupation will have occupancy sensors fitted to ensure that they are only on when required (e.g. waste storage, stair wells and plant rooms).

Wherever appropriate electric motors installed in central services will be of high efficiency type and included in the enhanced capital allowances list.

There is a preference for natural ventilation throughout the development, but any mechanical ventilation required as a result of Building regulations Part F (2006) will be fitted with variable speed motor drives controlled by air quality sensors wherever there are proven benefits. All apartments heating and hot water systems will have the facility for temperature and time control by the occupants.

The development will aim to minimise air leakage through improved sealing of the envelope.

All apartments will also be completed to the EcoHomes “very good” standard. Although EcoHomes is primarily an environmental standard, it does have an energy component that requires high standards of energy efficiency.

5 Supplying energy from renewable sources

5.1 Overview

This section sets out an option appraisal for the provision of energy from renewable sources within the development at 100 Park Village East. Recommendations are made as per the feasibility of including renewable sources in the Development.

Strategies are developed to show how the current policy requirements of a 10% reduction in CO_2 emissions through integration of renewable energy will be met.

5.2 Technologies

The following renewable energy sources are considered for the energy strategy, based on the London Renewables Toolkit:

- Biomass heating
- Biomass CHP
- Ground source heating/cooling
- Small scale wind turbines
- Solar photovoltaics
- Solar thermal collectors

5.3 Biomass Heating

Using wood fuel for heating is one of the oldest forms of renewable energy systems. Modern biomass heating uses locally sourced wood chip, or wood pellets, in a specially designed boiler which combusts the wood fuel at high temperature, attaining very high efficiencies, to produce hot water, for space or water heating, with minimal emissions.

The key issues for wood fuel heating are adequate fuel supply, suitable wood fuel handling systems and sufficient space allowance for the increased plant size.

In order to minimise the handling of wood fuel by appropriate facilities maintenance staff a biomass boiler system must handle fuel in a manner which is fully automated. The main criteria for the system are:

- Problem-free fuel feed from bunker to boiler;
- Rapid and simple on-site cycle for delivery vehicles, to minimise fuel costs;
- Use of simple tipper trucks or trailers to minimise fuel delivery costs;
- A maximum delivery frequency of once per week.
- Sufficient plant room allowance and access for flue and LTHW distribution.

Bio-diesel has not been considered for this development since it is still very much in it's infancy in the UK and the fuel is considered more appropriate for transportation uses, where it has a higher value. Further, there are still uncertainties regarding the supply chain. Additionally, the issues of exhaust fumes would require careful consideration when located in a built up area and as part of a residential development.

5.3.1 Achieving Policy Targets

A biomass boiler providing shared heating is a feasible way to reduce the development's CO_2 emissions by 10%. If the boiler displaces gas it will have to produce 72MWh/year in order to provide such emissions reductions. Assuming that the boiler will be operational 5 hours per day, 7 days per week, from December to February inclusive and 3 hours per day, 7 days a week in October, November and March, this gives a capacity factor of approximately 8.3%. Therefore, to produce 72MWh/year the boiler will have to have a capacity roughly 100kW and will cost approximately £30,000, excluding flue and connection to the wider heating system. The carbon mitigation cost for this system will be in the region of £2.2/kgCO_2.

The boiler should be installed alongside a gas heating system and in this case, if used preferentially over the gas boiler, it may have a greater capacity factor than assumed above, leading to a larger reduction in the CO_2 emissions of the development. Most boilers can operate at as little as 25 – 30% of their full capacity.

The main challenges to surmount in installing this technology are securing a consistent fuel supply, finding space for the fuel storage and boiler system and ensuring there are sufficient access facilities for fuel delivery. There are also issues associated with the exhaust fumes and ash removal.

5.3.2 Fuel Storage and Deliveries

The storage capacity needed depends on the fuel utilised. If it is assumed that the boiler runs to the schedule detailed above, it is possible to calculate the required storage necessary to ensure a maximum frequency of fuel delivery of once per month in the winter months. For the two most common fuels, wood chip and wood pellets, assuming a boiler efficiency of 90%, the capacity necessary would be approximately 31 and $8m^3$ respectively. This is calculated to allow for 10% space for back up stock and 10% space for lost storage due to difficulty of completely filling the space.

The advantages and disadvantages of wood chip and wood pellets are summarised in the table below.

Fuel	Advantages	Disadvantages
Wood Pellets	Easy to handle, flows predictably can even be pneumatically pumped into storage	More expensive, almost twice as expensive as wood chips due to increased processing
	Higher energy density; more heat per volume means less storage space required	
	Energy content is more consistent than wood chip	
Wood Chips	Cheaper than wood pellets. Less processing required.	Lower energy density requiring more storage space.
		Less easy to handle. Although there are solutions for delivery and usage logistics, these are likely to be more complicated that for wood pellets

It is thought that for this development, given the restrictions concerning space and access, that wood pellets are the preferred fuel. These can be delivered pneumatically into storage from a distance of up to 20m and have an energy density nearly four times that of wood chips.

The Energy Crops Company will deliver wood pellets to Camden for a cost of approximately £180/tonne or 3.75 pence/kWh of heat. This may be lower if a long-term contract is agreed upon. Deliveries can be between 5 and 18 tonnes. 5 tonnes of wood pellets will occupy $9.5m^3$ and allow a 100kW boiler to run at full capacity 24 hours per day for 10 days. Realistically the storage capacity necessary to accommodate 5 tonne deliveries is at least $12m^3$ because of the factors discussed above. This equates to a fuel store with dimensions of 2m x 3m x 2.5m high (most fuel storage solutions have sloping floors). The delivery vehicle is approximately the size of a standard fire engine.

The Energy Crops Company source their pellets from within the UK, either from waste wood or FSC certified forest. If waste wood is not burned it is often buried in landfill sites where it will biodegrade and produce methane, a far more potent green house gas than CO_2. For forest to be FSC certified two trees must be planted for every one felled. For these reasons, wood pellets from the Energy Crops Company are considered to be CO_2 neutral.

5.3.3 Plant Space

As well as storage space, the boiler will require significant plant space. The minimum plant space required for an indicative boiler, the 100kW USV 100 from KWB, is 2.17 x 3.14m or approximately $7m^2$ with a minimum height of 2.4m.

There will be an additional requirement for a buffer tank. This is because the boiler has a 15 minute burn-out and start-up time. This allows the boiler to operate more efficiently and better match the heating loads of the building. Therefore in essence the heating is supplied by the buffer tank which is in turn supplied by the biomass boiler.

5.3.4 Autonomy of Plant

Most modern biomass boilers operate with a fair degree of autonomy, for example they can have automatic:

- Thermal control; control system will regulate output down to 25 – 30% of rated power and shut the boiler down when necessary
- Ignition; includes electric element that will relight the boiler when necessary
- Fuel feed; auger transports fuel safely and reliably to boiler with burn-back control
- De-ash; auger removes ash from boiler grate and compacts it into removable compartment for disposal
- Cleaning; the heat exchanger will get covered in ash and must be cleaned, many models have automatic cleaning

The boiler will of course require general maintenance and the flue will need regular cleaning.

5.3.5 Towards Emerging Targets

As discussed above the Mayor of London's emerging target requires developments to achieve a reduction in their carbon dioxide emissions of 20% from onsite renewable energy.

The boiler described above that will meet the 10% target would be providing approximately 25% of the development's space heating and hot water needs. It is possible to supply more than 25% of the annual space heat and hot water demand, thereby increasing the development's emissions reductions and moving towards the emerging target of 20%. However, this will have impacts on the factors discussed above such as fuel storage, frequency of fuel delivery and ash removal and plant space.

5.3.6 Air Quality

The impact on immediate air quality should be assessed in the context of the Camden UDP policies that relate to air quality, including EN8 – *The council will seek to ensure that all new development is designed to avoid detrimental alterations to the air quality and microclimate in the surrounding area, especially where this may be caused by motor vehicles, and wherever possible to improve them.*

In 2002 all of Camden was declared an Air Quality Management Area (AQMA) and an action plan adopted to improve air quality and in February 2000, Camden revoked existing smoke control orders and made a new order which made it an offence for anyone to emit smoke from any chimney anywhere in the borough and also made it an offence to acquire any unauthorised fuel such as coal or wood which is to be burned on an unauthorised fireplace.

The Air Quality Officer and Camden Borough Council has advised PBA that there are no specific guidelines for biomass boilers with regard to air quality and that each project will be considered on its merits. Our experience of installing biomass boilers in the London area is that the boiler should be included in "The Smoke Control Areas (Exempted Fireplaces) (England) (No.2) Order 2006". The example boiler discussed above, the 100kW USV 100 from KWB, is included in this order.

5.4 Biomass CHP

For CHP to be appropriate there should be a significant and constant heating need, for example a swimming pool, which does not exist in this case. Additionally the unproven nature of this technology, together with the high maintenance requirement, means it is not considered further in this report.

5.5 Ground coupled heating and cooling systems

Heat Pumps upgrade “low value” energy through the use of electrical power via a vapour compression refrigeration cycle.

There are two types of ground source heat pump system; open loop and closed loop.

Open loop systems or Aquifer Thermal Storage systems rely on the temperature of ground water, or water contained within wells to provide cooling. The presence of an aquifer or well is therefore essential and an abstraction licence would be required from the Environment Agency to utilise such a system. This is not considered suitable for the development.

Closed loop systems may be vertical or horizontal in configuration and where vertical in configuration can additionally comprise dedicated boreholes, energy piles, or a combination of both.

A dedicated borehole is, as the name suggests, a borehole which is used purely for a ground source heat pump system. There is no scope for a dedicated borehole system in the development as the boreholes cannot be placed under built structures and there is no open space within the development to locate the boreholes.

An energy pile is where a structural pile is additionally utilised to accommodate pipe-work for a ground source heat pump system. This system is more complex in construction terms and less efficient since structural piles are usually buried to a more shallow depth (typically only 10 - 20m deep) and heat cannot as easily be dissipated through the concrete. Additionally, energy pile solutions are not common in the UK and the specification of such a system may create difficulties in the appointment of a main contractor for the development due to their unfamiliarity or the high cost risk they may attach to such systems.

For these reasons a GSHP is not considered appropriate for this development.

5.6 Wind turbines

There is no land available in the immediate area for a large scale wind turbine. Small scale roof mounted wind turbines could provide some contribution to renewable generation were it not for limitations imposed by the strategic view requirements for St Paul's cathedral. We have therefore discounted wind turbines as a possible source of renewable energy.

5.7 Solar photovoltaic cells

Solar photovoltaic (PV) cells transform the photons within sunlight into useful electrical energy. They are made from semi-conductor material and can be integrated into the fabric of the building as a roof covering or as glazing, or mounted on the building.

To achieve optimum electrical generation throughout the year, the PV arrays should be approximately south facing and inclined at an angle of 30º to the horizontal. However, should planning restrictions prohibit this due to the visual impact, or the system selected directly replaces a roofing element, the PV system can be laid flat. However, this results in a reduction in the efficiency of the system. It is therefore considered appropriate that roof mounted panels inclined at an angle will be considered for this development.

PV systems require little maintenance. Regular inspection of the PV arrays for damage or dirt and annual servicing of inverters and electric controls is required. PV is ideally suited to residential applications due to its low maintenance requirement and visibility. It is however usually more expensive than other forms of renewable electricity generation.

It is unlikely that PV modules could be integrated into the building cladding since there are a number of tall surrounding buildings which will give significant shading. However, none of these buildings is significantly taller than the proposed development, so there exists the possibility of mounting a PV array on the roof. The preliminary plans show that the penthouse apartment has a flat roof, approximately $94m^2$.

The PV array system considered at this stage is the Sharp NE-Q5E2E Polycrystalline stand-alone panel system. The modules would be within a standard frame attached to the roof, not as a building integrated system. Dimensions are 0.826 m x 1.575 m giving an area of 1.30m^2 per panel. This area provides 165Wp per panel, equal to 127 Wp/m^2. Annual output for the UK is estimated to be equal to 750 kWh/kWp. Therefore panel annual output is 124 kWh per unit or, by area, 95 kWh/m^2.

If a PV array of 94m^2 were installed, at 30^o to the horizontal, facing south this would have a capacity of almost 12kWp and produce approximately 8.9MWh/year, providing a CO_2 saving of 3.8 tonnes/year or 2.8% of the development's total emissions. This is a best case scenario as the actual array may need to be smaller, and may not be able to be at the correct angle and orientation, meaning a lower output.

The above array would cost in the region of £85,000 giving a carbon mitigation cost of £22/kgCO_2.

5.8 Solar Thermal Collectors

A solar thermal collector system provides hot water by using the energy present in sunlight to heat a collector; this energy is then transferred to a circulating fluid and used to heat hot water.

There are two types of solar thermal collector. The lowest cost type, flat plate collectors, must be mounted at 30° to the horizontal, usually on roof mounted A-frames. This type of collector produces around 250 kWh/m^2/annum. A 20m^2 system would produce around 1,000 litres per day during summer. However, such a system would be visible and potentially visually intrusive.

A vacuum tube system can be mounted on any surface with a south facing aspect, including walls, although they will operate at a lower efficiency when vertically mounted. These collectors are more efficient than the flat plate type, typically producing up to 450kWh/m^2/annum for small systems and in excess of 600kWh/m^2/annum for large scale systems when they are orientated approximately south facing and inclined at an angle of 30^o to the horizontal.

Solar thermal collectors generate the highest volume of hot water in the summer months, due to the longer daylight hours and more intense insolation.

Solar thermal systems require little maintenance. Regular inspection and servicing are required including checks to: the collector glazing for damage or dirt; electric controls and temperature sensors; pump sets. This is over and above the maintenance requirements of a gas fired boiler installation.

The inclusion of solar thermal collector systems to meet part of the hot water requirements does not obviate the need for another hot water generating system, since the winter hot water demand will only be partially met by the solar thermal collectors.

If an evacuated solar collector of $94m^2$ were installed, at 30^o to the horizontal, facing south this would have produce approximately 49MWh/year, providing a CO_2 saving of 9.3 tonnes/year or 6.8% of the development's total emissions. This is a best case scenario as the actual collector may need to be smaller, and may not be able to be at the correct angle and orientation, meaning a lower output.

A system of this size is likely to cost in the region of £94,000 for collectors, pumps and storage tank. This equates to a carbon mitigation cost of £10.1/kgCO_2.There is additionally a space requirement for the extra storage tank. Such a system would also require centralised boiler plant from which the hot water is fed to the apartments. This would in turn require metering, and subsequently billing of the heat supplied and maintenance of the plant.

6 Supplying energy efficiently

This section outlines how energy is supplied efficiently to the elements of the Development in line with the Mayor’s Energy Hierarchy.

Natural gas fired condensing boilers will be provided to the development, as the main heating source. The operating temperature of the boilers will be automatically adjusted so as to ensure that maximum efficiency is achieved at all times.

All plant operations will be automated and will be programmed to function so as minimise energy use and CO_2 emissions. To this end, if a biomass boiler is installed it should be prioritised over the gas boilers.

7 Conclusions

7.1 Overview

The following section summarises the energy strategy for the elements of the Development to meet the Mayor of London's Energy Strategy. Wind and ground source heating and biomass CHP have been discounted as unfeasible for this development; the suitability of the remaining technologies is summarised below and in a table in Appendix A.

7.2 Solar PV

Even using the most optimistic figures as to the roof space available it is unlikely that a solar PV array will be able to provide more than a 2.8% reduction in CO_2 emissions. Additionally it has a very high cost, estimated at £22/kgCO_2 saved. It is not thought that solar PV is appropriate for this site.

7.3 Solar Thermal

Even using the most optimistic figures as to the roof space available it is unlikely that a solar thermal collector will be able to provide more than a 6.8% reduction in CO_2 emissions. This would cost in the region of £94,000, giving a carbon mitigation cost of £10.1/kgCO_2. It is considered that because of its limited potential impact and requirement for tank space under the roof of the building, this technology is a not feasible of achieving the necessary CO_2 reductions.

7.4 Biomass Heating

This technology has the capacity to provide the 10% reduction in CO_2 emissions required. It is estimated that a 100kW system will provide sufficient heat to achieve this reduction and would cost in the region of £30,000 giving a carbon mitigation cost of £2.2/kgCO_2.

The biomass boiler would be installed alongside a gas fired system and will be prioritised over the gas system, it could provide more than the reduction above.

Achieving more than a 10% reduction in CO_2 emissions would also be possible by installing a boiler with a greater output than 100kW. Reasonable endeavours will be made to achieve this but the largest feasible boiler size will be constrained by factors discussed above including space available for plant and fuel storage and frequency of fuel delivery.

The main challenges to surmount in installing this technology are securing a consistent fuel supply, finding space for the fuel storage and boiler system and ensuring there are sufficient access facilities for fuel delivery. There are also issues associated with the exhaust fumes and ash removal, but there are no obvious reasons to think that these challenges cannot be overcome.

It is thought that biomass is the leading technology to ensure that the development fulfils its obligations under the Mayor of London’s Energy Strategy.

8 Appendix A

Technology	Potential Capacity for CO2 Savings		Cost/£/kgCO2	Comments
	Absolute/tonnesCO2/ year	% Development Emissions		
Biomass	At least 13.6	At least 10%	2.2	Requires consistent fuel supply, space for the fuel storage and boiler system and sufficient access facilities for fuel delivery. Also issues associated with the exhaust fumes. Considered good option.
Solar PV	3.8	2.8%	22	Assumes 94m2 of South facing roof space at 30 deg. to horizontal is available.
Solar Thermal	9.3	6.8%	10.1	Requires 94m2 of South facing roof space at 30 deg. to horizontal.
Biomass CHP				No significant and constant heating need, for example a swimming pool. Unproven nature of this technology, together with the high maintenance requirement, means it is not considered suitable
GSHP				No space available for boreholes. Not considered suitable for this project.
Wind				No land available for a large scale turbine. Small, roof mounted turbines could provide some renewable generation were it not for limitations imposed by the strategic view requirements for St Paul’s cathedral. We have therefore discounted wind turbines as a possible source of renewable energy.