southfacing

Heath Park
Residential Development

Sustainable Energy Preliminary Report

15th January 2008

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Review Status

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1.	10/01/08	180	Draft report issued to Alison Pearce (Robert Adams Architects), Elizabeth Howe (Montague Evans), Bob Bashford (KUT Partnership), Mark Walker (Clifton Nurseries) and Rebecca Jones and Ralph Nicholls (Darling Associates) for comment.
2.	15/01/08	180	Final report issued to Alison Pearce (Robert Adams Architects), Nick Woodruff (APS), Elizabeth Howe (Montague Evans), Bob Bashford (KUT Partnership), Mark Walker (Clifton Nurseries) and Rebecca Jones and Ralph Nicholls (Darling Associates).

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TABLE OF CONTENTS

Introduction

This report describes studies which have been undertaken to identify an appropriate sustainable energy strategy for the Heath Park residential development, London NW3.

The energy performance of the building has been calculated using Carbon Checker (SBEM) due to the building size and complexity. This program can be used in this case to assess compliance with the Building Regulations Approved Document Part L1, which came into force in England/Wales 1st April 2006.

The development consists of one large residential building. The feasibility studies undertaken in this report have been structured in accordance with the Mayor of London's Energy Hierarchy (Be Lean, Be Clean, Be Green). The developer and design team are committed to delivering a development with low environmental impact. Issues of sustainability will be constantly monitored and optimized throughout the design and operation of the development. The target is to provide at least **20%** of the energy requirement from renewable sources, and to achieve a **25%** improvement on the Target Emission Rate as one of the mandatory requirements to achieve Code for Sustainable Homes level 3.

Summary

It is proposed that a combined heat and power system (CHP) represents the most suitable route to achieving an exceptional level of CO_2 savings. It may be a sufficient and sensible option to provide gas fired CHP, which on its own provides significant CO_2 savings enough to meet a 20% reduction (actually 32%) in carbon emissions. Clarification of the terms of the Camden Planning Guidance 2006 document is needed, and if necessary, the CHP system could be fuelled from a low-carbon fuel such as biodiesel. It is advised that this is discussed in more detail with the Planning Department.

The most cost effective way to meet the necessary targets would be to install a biomass boiler, probably running on wood chips. This requires that a suitable fuel source be found and that it is appropriate for the development.

A final option would be to utilise ground source heat pumps, but an in-depth study into the savings achievable would need to be undertaken given the borderline nature of the results. Also, due to the presence of the Northern Line beneath the site, a borehole installation is unlikely, and a horizontal loop would have to be considered however, TOP (Tree Preservation Order) trees would need to be incorporated into the plans.

'Be Lean, Be Clean, Be Green'

The Mayor of London has proposed a set of principles ('The Mayors Energy Hierarchy') to guide design development and decisions regarding energy, balanced with the need to optimise environmental and economic benefits. These guiding principles are recommended to be applied in sequence, as follows:

- **Be Lean** - Reduce energy loads to a minimum through energy efficient building design, heating and lighting systems, and efficient appliances;
- **Be Green** - Use efficient supply technologies such as Combined Heat & Power and Community Heating
- **Be Clean** – Apply on-site energy generation where technically and economically viable.

In response to this energy hierarchy we have considered each section in turn and based our resulting strategy on calculations and comparison of various energy efficiency measures and technologies.

1. Be Lean

The first stage is to provide an energy efficient building. SBEM calculations using Carbon Checker have been used to estimate the space heating, hot water and electrical annual energy demands as a baseline for the building.

1.1 Assumptions made

After consultation with the design team, the following specifications have been assumed as a means of providing an 'early doors' energy demand model, maximizing efficiency.

1. All dimensions taken from architects drawings
2. Floor-to-ceiling height various from floor to floor
   Basement - 3.00 m
   Ground floor – 3.25 m
   First Floor – 2.70m

3. U-values for major elements are taken as:

Solid Floor:	0.22 (Solid ground floor – 2006 Part L)
Intermediate floor	1.25 (notional Building)
External wall:	0.27 (cavity wall 2006 Part L)
Internal walls:	0.35 (Metal cladding wall 2006 Part L)
Roof:	0.13 (Pitched roof 2006 Part L)
Glazing:	2.12 (notional glazing 2006+ hardwood frame)
Door:	1.61 (insulated personal door)

4. A design air permeability rate of 7 m^3/hm^2, with no mechanical ventilation and a fan in each bathroom.

5. A gas-fired LTHW boiler with 91% efficient condensing boiler and radiator system, with thermostat, TRVs and load compensator and DHW boiler for hot water. There is also potential for metering.

6. All windows to have average overshading from surroundings.

7. No secondary heating included as part of these initial calculations.

1.2 Results

Building Regulations 2006 compliance is now based on whether the Building CO_2 Emissions Rate (BER) is lower than a Target CO_2 Emissions Rate (TER). The SBEM calculations undertaken as part of this report enable the average BER and TER for the site to be calculated.

Basic model:

Heath Park TER = **38.84** kg CO_2/m^2
Heath Park BER = **37.58** kg CO_2/m^2
Notional Emission rate = **50.77** kg CO_2/m^2
Improvement factor 0.15
Low/zero carbon Factor 0.1

This gives an improvement over the TER of **3.24%**

Then, in order to assess the impact of improving the building envelope, several variations were tested, the most effective of which was improving the glazing U-value:

As based model except windows U- values has been improved from 2.123 to 1.6:

Heath Park TER = **38.84** kg CO_2/m^2
Heath Park BER = **37.25** kg CO_2/m^2
Notional Emission rate = **50.77** kg CO_2/m^2
Improvement factor 0.15
Low/zero carbon Factor 0.1

This gives an improvement over the TER of **4.09%**

It can be seen from these figures that, due to the nature of the building and the overall energy demand, improvements to the building fabric have a relatively small impact.

2. Be Clean

In consideration of the “Be Clean” principle, a preliminary look at the appropriateness of a Combined Heat and Power (CHP) system for the proposed development has been undertaken. Community heating has also been considered.

2.1 Combined Heat and Power

For CHP to be economically viable, the following should be present at a site:

- Simultaneous demand for heat and electricity
- Heat: power ratio of about 1.6 to 1
- Large and constant heat demand: over 4000 full load run hours per year

The presence of a swimming pool within the development provides a large and regular heat load, ideally suited to the application of CHP. The parameters below are assumed:

Seasonal Thermal Efficiency factor	0.50
Building Space Heating Supplied	50%
Building Hot Water supplied	50%
Heat to Power ratio	100%

SBEM calculations including CHP give the following results:

Heath Park - TER = **38.84** kg CO_2/m^2
Heath Park - BER = **26.1** kg CO_2/m^2
Notional Emission rate = **50.77** kg CO_2/m^2
Improvement factor 0.15
Low/zero carbon Factor 0.1

Improvement of **32.8% from the TER**

By adding CHP using biomass (use of renewable energy potentially as part of planning requirements):

Heath Park - TER = **38.84** kg CO_2/m^2
Heath Park - BER = **16.25** kg CO_2/m^2
Notional Emission rate = **50.77** kg CO_2/m^2
Improvement factor 0.15
Low/zero carbon Factor 0.1

Improvement of **58.2% from the TER**

The sizing of a suitable CHP unit is a complex task and beyond the scope of this study, but assuming a maximum output of 15kWe, the installed cost would be expected to be about £15,000.

2.2 Community Heating

Community heating means the supply of heat to dwellings through a well insulated heat pipe network transporting hot water or steam from a centralized heat production facility in a closed loop. Such systems are widely used on the continent, less so in the UK. The heat source can be changed in the future, giving good flexibility once the heat network is installed.

As Heath Park is a single dwelling, and there is to be no energy share with Heath House nearby, community heating is not applicable in this instance. However, if CHP is employed, the possibility of exporting excess heat in order to increase CHP run time should not be overlooked.

3. Be Green

From the suggested renewable energy systems listed in the London Renewables Toolkit, a number of potential technologies were identified for consideration.

HEATING

3.1 Solar Hot Water

Solar thermal collector systems have been mentioned as a possible route to demonstrating sustainability, but with a requirement for 20% CO_2 to come from renewables, they will not be sufficient in themselves. In the UK, SHW is used to provide preheating to water before it enters the boiler. As such, and taking into account the average incident radiation, UK installations can typically manage about 10% of a site's energy demand.

In this instance, assuming that 55% of hot water demand can be met by SHW, a CO_2 saving of only 9.63% could be achieved. This would require an area of 87.3m^2 for flat plate collectors, or 68.1m^2 for evacuated tubes, at an estimated cost of £35,000 or £41,000 respectively. Also, given the location and nature of the development, they may not be acceptable on aesthetic and planning grounds.

3.2 Ground Source Heat Pumps

Ground source heat pumps extract heat (or coolth) from the ground. With the amount of land available this technology could be implemented on this development, although a ground conditions survey would need to be carried out were it to be considered further. Due to the presence of the Northern Line beneath the site, a borehole installation is unlikely, and a horizontal loop would have to be considered however, TPO (Tree Preservation Order) trees would need to be incorporated into the plans.

GSHPs are not entirely renewable, as they require electricity to run the compressors. The ratio of heat output to electricity generated is called the coefficient of performance (CoP). In order to meet the required target for CO_2 reduction it would be necessary to achieve a CoP of 5, and to fulfil 86.5% of the heat demand through GSHP. This figure would be difficult to achieve, and in a 'very compact' configuration would require an estimated 2500m^2 of land to be excavated. Based on an assumed cost of £800/kW, this would cost an estimated £24,000.

3.3 Biomass Boilers

Biomass boilers replace conventional gas boilers with a carbon neutral fuel such as wood pellets or waste brickettes. The site contains adequate space for these boilers and storage of the fuel. However, it should be noted that fossil fuels are used in the production, processing and transportation of biomass fuels and therefore care should be taken when choosing the fuel supplier and the distance and method of transportation. Ideally, fuel should be sourced within a 30 mile radius of the site, and this may be problematic given the London location. It is possible, however, that a suitable source of wood chips could be provided as a by-product of management of Hampstead Heath. These factors should also be considered as part of the provision of the biomass fuelled CHP unit mentioned earlier.

If only 40% of heat demand were met by biomass, a 21.1% reduction in CO_2 would be achieved, thus meeting the required target. If 100% of demand came from biomass, the reduction would be 52.8%. The estimated cost of such a system would be £6,500 per boiler.

ELECTRICAL PROVISION

3.4 Photovoltaic Cells

Provision of electricity from a photovoltaic (PV) roof mounted system has been considered, but it would require about 380m^2 of panels, at an estimated cost of £304,000. In addition to the issue of available roof space, this is clearly prohibitively expensive. Also, given the location and nature of the development, they may not be acceptable on aesthetic and planning grounds.

3.5 Rooftop Building Integrated Wind Turbines

Rooftop building integrated wind turbines have been considered, but, it would not be feasible to meet to the 20% target, requiring the equivalent of 25 Swift turbines at an estimated cost of £125,000. Also, given the location and nature of the development, it is unlikely that they would be acceptable on aesthetic and planning grounds.

4. Conclusion

In order to achieve the targets of 25% improvement on TER (Code for Sustainable Homes) and 20% provision from renewables, it can be seen that only three technologies present themselves as possibilities:

- Combined heat and power
- Ground source heat pumps
- Biomass boiler

The other available technologies are either prohibitively expensive, provide inadequate offsetting (see summary below) or may be ruled out on aesthetic or planning grounds.

Despite the large CO_2 savings made, gas-fired CHP may not be considered under the terms of the Camden Unitary Development Plan. As such, biofuelled CHP system may be required to make up the 20% renewables quota. This would require additional plant and management and should be clarified with Camden Planning Authority.

Ground source heat pumps could fulfil the renewables requirement, but would be pushed to the limit of what the technology can currently achieve. Further study would be required to validate the suitability of GSHP.

Biomass boilers provide a cheap and straightforward route to achieving the necessary targets, and could reduce the carbon output of the building by over 50%. A requirement for implementing this would be to guarantee a local, carbon-neutral biomass or waste fuel source.

Appendix – Results Table and Graphs

Technology Summaries

(CHP not shown due to uncertainty of installation size)

Solar Hot Water

% Carbon reduction	**9.63**	**%**
Flat plate area	87.30	m2
Flat plate system cost (approx)	£34,920.30	
£ invested per kg C saved	£15.24	
Evacuated tube area	68.10	m2
Evacuated tube system cost (approx)	£40,860.35	
£ invested per kg C saved	£17.83	

PV

% Carbon reduction	**20.17**	**%**
Collector area	380	m2
System cost (approx)	£304,000.00	
£ invested per kg C saved	£63.35	

Wind

% Carbon reduction	**20.04**	**%**
Number of Swift turbines	25	
System costs (approx)	£5,000	
£ invested per kg C saved	£26.22	

GSHP

% Carbon reduction	**21.26**	**%**
System size	28.878434	kW
System cost (approx)	£23,102.75	
£ invested per kg C saved	£4.57	

Biomass

% Carbon reduction	**52.83**	**%**
Contribution to site heating & hot water (%)	100	%
Additional system costs (approx)	£4,500.00	
6 Tonne shipments per year	7	
£ invested per kg C saved	£0.36	

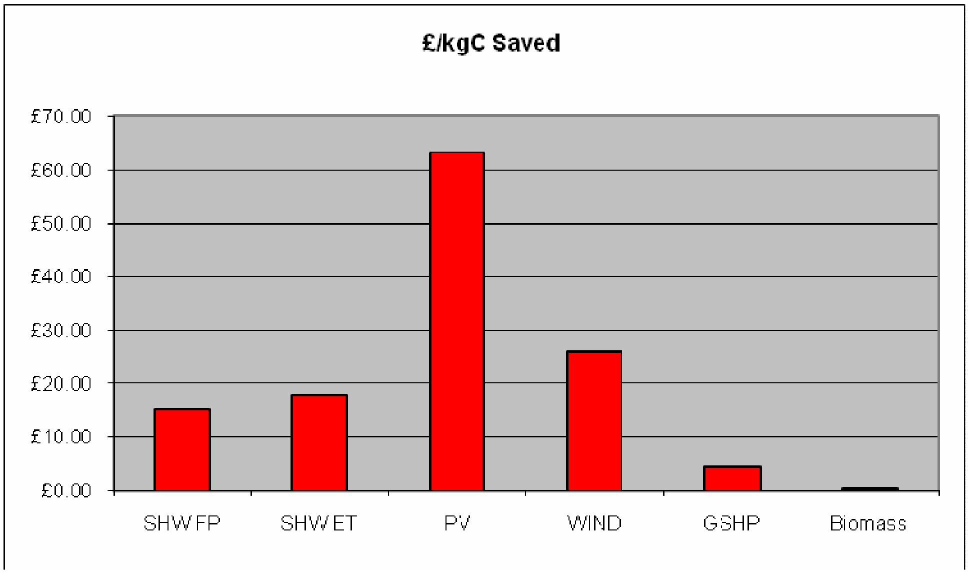

Fig 1: Graph showing renewable energy options in terms of £ per kgC saved, note this excludes CHP

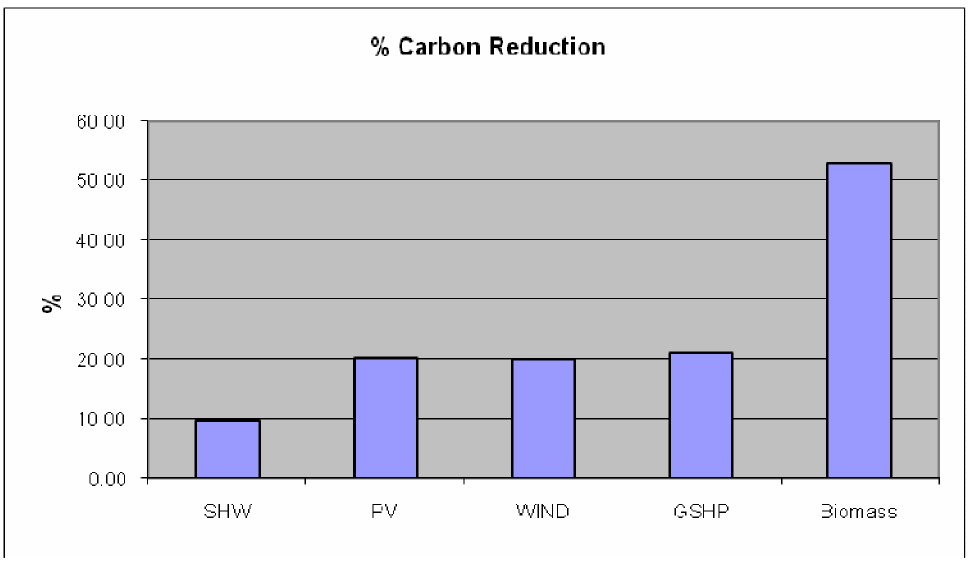

Fig 1: Graph showing renewable energy options in terms of direct percentage carbon reduction, note this excludes CHP