Energy statement

81 Charlotte Street & 6 Tottenham Mews
London
W1

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Contents

1 Introduction

This report provides an assessment of the overall energy requirements and associated carbon dioxide emissions for the proposed refurbishment and change of use at 6 Tottenham Mews, London W1.

The opening section of the report provides a baseline energy assessment of the proposed residential apartments. The baseline energy usage has been calculated based upon the basic requirements of current building regulations.

The report then details the passive energy saving measures that could be included within the design of the apartments, such as increased insulation, more efficient heating systems and reduced heat loss through ventilation. These passive energy efficiency measures will serve to reduce the need for energy in the apartments and reduce their CO_2 emissions.

The final section of the report sets out the feasibility of using renewable energy technologies to reduce the CO_2 emissions from the proposed dwellings by 20%. This is in line with planning policies and guidance relevant for developments in the London Borough of Camden.

2 Policy & context

2.1 National Policy

2.1.1 Kyoto protocol

The Kyoto protocol is an international treaty following the United Nations Framework Convention on Climate Change (UNFCCC) set out in 1992, which set targets for the reduction in emissions of greenhouse gases. The UK government signed the treaty in 1997, which to date 181 additional countries have also signed.

Following the signing of this protocol the European Union (EU) and UK government and regional offices have put in place measures to reduce the amount of energy consumed by new and existing buildings and therefore to reduce the amount of carbon dioxide emitted. These have included changes to the building regulations, national and regional planning policy documents relating to energy efficient development and the use of renewable energy.

2.1.2 Building Regulations – Part L1A and L2A (ODPM, 2005)

This section of the building regulations deals with the conservation of energy in buildings; specifically the energy used for space heating/cooling, water heating, cooking, lighting and appliances. Part L1A deals with new dwellings and Part L2A deals with all other new buildings.

The methodology for the assessment of such has been adopted from the Building Research Establishment's (BRE) Domestic Energy Model (BREDEM) and Simplified Building Energy Model (SBEM) energy assessment methods.

Both of these methods require the calculation of both a target emissions rating (TER), which assumes standard or typical building components and the calculation of the buildings actual emissions (DER for SAP or BER for SBEM). It is expected that the buildings actual emissions be lower than the target emission rate.

2.1.3 Planning Policy Statement 22: Renewables (ODPM, 2004)

Planning Policy Statement 22 covers the consideration of issues relating to renewable energy technologies and their application to new developments. There is also a Companion document, which contains some technical advice and guidance on the various individual renewable technologies and examples of good practice within development plans and developments.

2.2 Regional Policy

2.2.1 The Energy Strategy (Mayor of London, 2004)

"The Mayor has defined an Energy hierarchy to help guide decisions about which energy measures are appropriate in particular circumstances. When each step of the Hierarchy is applied in turn to an activity, it will help ensure that London's energy needs are met in the most efficient way:

i. Use less energy (Be lean)

ii. Use renewable energy (Be green)

iii. Supply energy efficiently (Be clean)

It is therefore important for energy efficiency as well as renewable energy to be considered in each new development in London. This means that the buildings will use less energy and therefore need to use a smaller amount of renewable energy to supply the same proportion of the site's needs.

Using less energy, for example simply by switching off lights or insulating buildings, ensures that the demand for energy is minimised. Maximising the use of renewable energy conserves natural resources, and reduces the amount of carbon dioxide released when energy is used. Finally, by supplying the remaining energy demand efficiently, for example from combined heat and power, the use of fossil fuels is minimised, further reducing overall carbon dioxide emissions.

The Energy Hierarchy can be used to guide the decisions of a range of stakeholders, from architects, planners and developers to individuals in the home."

2.2.2 The London Plan (Mayor of London, 2004)

"The Mayor will, and boroughs should, in their DPDs adopt a presumption that developments will achieve a reduction in carbon dioxide emissions of 20% from on site renewable energy generation (which can include sources of decentralised renewable energy) unless it can be demonstrated that such provision is not feasible. This will support the Mayor's Climate Change Mitigation and Energy Strategy and its objectives of increasing the proportion of energy used generated from renewable sources."

2.3 Local Policy

2.3.1 London Borough of Camden Unitary Development Plan (Camden Council, 2006)

SD9: Resources and Energy

C - 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. The Council may use conditions or planning obligations to secure recycling of materials on site and/or use of recycled aggregates in major schemes."

1.64 "The Government's Climate Change Programme has set a target that 10% of the United Kingdom's electrical requirements are to be met from renewable resources by 2010, and 20% by 2020. Therefore, the Council expects major developments of 1000m2 or 10 housing units or more to incorporate renewable energy production equipment to provide at least 10% of predicted energy requirements. The most likely sources of renewable energy for developments in Camden are solar water heating, photovoltaic cells, small-scale wind turbines, passive solar energy, natural ventilation and borehole cooling. Developers should give details of how they have addressed these issues in any design statement that is to be submitted under policy B1. Although not strictly renewable, combined heat and power through its far greater energy efficiency, also has enormous potential for reducing carbon dioxide emissions. It can be used at both large and small scale. Special regard should also be paid to the Greater London Authority's 'The Mayor's Draft Energy Strategy', (2002). Further guidance on energy matters and sustainable buildings is contained in supplementary guidance and the Camden Green Buildings Guide."

3 Methodology

The energy requirements for space heating, water heating and ventilation within each of the residential dwellings have been calculated using the Standard Assessment Procedure (SAP) in line with Part L1a of the building regulations. This also follows the methodology used for the London Renewables Toolkit and the Code for Sustainable Homes guidance notes on preparing Energy Statements.

3.1 SAP assessment

A SAP assessment calculates the estimated energy running costs, per square metre, of a domestic property. Including; it's space and water heating systems, internal lighting and any renewable energy technologies. The SAP energy rating of a dwelling is presented in a scale from 1 to 100+, the higher the number the lower the running costs.

The SAP assessment also calculates the estimated amount of Carbon Dioxide emissions, per square metre, from the dwelling. Including; space heating, water heating, internal lighting and ventilation systems.

The results of the SAP assessment form a comparison between a baseline condition, called the 'Target Emissions Rate' (TER) and a 'Dwelling Emissions Rate' (DER). The DER is calculated based upon the form, fabric, systems and orientation of the actual proposed dwelling. The TER is calculated by applying minimum standards of building fabric and systems to the same built form. A dwelling must have a DER lower than the TER to comply with Part L1a of the building regulations. Meaning that the carbon dioxide emissions of the proposed building are lower than that of a notional 'Target' building.

3.2 Energy Statement

The London Renewables toolkit dictates that an energy statement should form a comparison between a 'baseline' condition and the proposed condition. This is consistent with the TER and DER produced in a standard SAP assessment, except that it should also consider the energy used for lighting, cooking and home appliances. This has been calculated in addition using the BREDEM-12 methodology produced by the Building Research Establishment (BRE).

3.3 Renewable energy feasibility study

The methodology for assessing the feasibility and cost effectiveness of renewable energy technologies is given in the Greater London Authority (GLA) guidance document 'The London Renewables Toolkit'.

The assessment methodology given within this document follows from the SAP assessment and energy statement detailed above. It uses the energy demand and CO_2 emissions figures that have been calculated for dwellings following the inclusion of passive energy efficiency measures. It then calculates how much CO_2 can be further reduced by the inclusion of differing renewable energy technologies, providing a comparison across feasibility, cost and CO_2 reductions.

4 Assumptions & information

4.1 Dwelling energy calculations produced by EB7 Ltd (using SAP)

Dated 17th December 2009

4.2 Proposed scheme drawings received from Formwork Architects: -

01 existing plans.dwg

02 existing elevations.dwg

03 existing sections.dwg

06 proposed elevations.dwg

07 proposed sections.dwg

08 proposed plans.dwg

Received 14th December 2009

5 The Site & Proposal

The proposed development is located at 81 Charlotte Street and 6 Tottenham Mews, London W1. The area surrounding the site is densely populated with mixed use buildings.

The current buildings contain 3 residential apartments over 3 floors within 81 Charlotte Street. The lower two apartments are to be re-fitted, but will remain self contained dwellings. The proposed development will create 2 additional apartments adding additional floors at roof level within 81 Charlotte Street and 6 Tottenham Mews.

It is the 2 new apartments within 6 Tottenham Mews and the extended apartment on the upper floors of 81 Charlotte Street that have been considered within this report.

6 Baseline energy results

The baseline energy requirements for the 3 apartments have been calculated assuming basic compliance with the building regulations i.e. the Target Emissions Rate (TER) together with an approximation of the energy used for cooking, lighting and appliances using the BREDEM-12 calculation.

The notional buildings used in the TER calculations are of the same size and shape as the proposed dwellings and have the following specifications: -

6.1.1 Heating system

- SEDBUK 78% efficient mains gas boiler
- Hot water cylinder insulated with 35 mm of factory applied foam and Cylinder thermostat
- Primary pipework not insulated
- Water pump in heated space
- Programmer + room thermostat + TRVs
- Separate time control for space and water heating

6.1.2 Building fabric

- External walls - 0.35 W/m^2 K
- Ground floor –0.25 W/m^2 K
- Roof – 0.16 W/m^2 K
- Doors and glazing – 2.0 W/m^2 K
- Glazing = 25% of total internal floor area

6.1.3 Ventilation

- Air permeability rate of 10m^3/h/m^2 (@50 Pascals)
- 3 No. extract fans

Table 6.1 – Baseline energy consumption and CO2 emissions

Energy use	Floor area (m^2)	Total demand (kWh/yr)	Demand by floor area (kWh/yr/m^2)	CO2 emissions (Kg CO_2)	CO2 emissions by floor area (Kg CO_2/m^2)
Gas for space heating	260	15922.7	61.3	3089.0	11.9
Gas for water heating		10478.5	40.4	2032.8	7.8
Electricity for space heating (secondary)		1380.0	5.3	582.3	2.2
Electricity for pumps & fans		525.0	2.0	221.6	0.9
Electricity for lighting, appliances and cooking		8362.9	32.2	3529.2	13.6
Total gas demand		26401.2	101.7	5121.8	19.7
Total electricity demand		10267.9	39.5	4333.1	16.7
Total Site		**36669.1**	**141.2**	**9454.9**	**36.4**

7 Design for energy efficiency

The Mayor of London's Energy Strategy details a hierarchy of measures to be employed within new developments to reduce the amount of CO_2 they produce. This is as follows; use less energy (Be lean), use renewable energy (Be green) and supply energy efficiently (Be clean).

This section sets out the measures included within the design of the apartments that aim to reduce the demand for energy, both gas and electricity (not including energy from renewable sources).

The table at the end of this section details the amount of energy used and CO_2 produced by the building before and after the energy efficiency measures have been included. From these two sets of figures the overall reduction in CO_2 emissions, from passive design measures, can be calculated.

To achieve reductions in energy demand the following measures have been included within the design and specification of the apartments:

7.1.1 Heating system

The assessment has assumed that the primary heating system for each dwelling will consist of a high efficiency condensing gas boiler feeding a highly insulated hot water storage tank. This will in turn provide domestic hot water and space heating through wall mounted radiators.

- High efficiency 'A' rated boiler (92% SEDBUK efficiency)
- >100mm factory insulated hot water storage tank
- Insulated primary pipework

To increase the efficiency in the use of the heating system, the following controls will be used in a 'boiler interlock' system to eliminate needless firing of the boiler.

- Cylinder thermostat
- Room thermostat
- Individual Thermostatic Radiator Valves (TRV's)
- Programmer/timer to control space and water heating separately

7.1.2 Building fabric and ventilation

To reduce the amount of energy required for space heating within the apartments it is anticipated that the following building fabric and ventilation measures will be included:-

- External walls - 0.25 W/m^2 K - expanded/extruded polystyrene (EPS) insulation
- Party walls – 0.125 W/m^2 K - expanded/extruded polystyrene (EPS) insulation (assumes semi heated space adjacent to commercial properties)
- Roof – 0.15 W/m^2 K - 200mm EPS
- Glazing - 1.4 W/m^2 K – wooden or u-PVC, low emissivity double glazing
- Air permeability rate of $5m^3/h/m^2$ (@50 Pascals), which is half the minimum requirements of current building regulations
- The assessment also assumes that extract ventilation will be provided using low-energy fans in the kitchens and bathrooms

7.2 Energy efficiency results

The following table shows a comparison between the CO_2 emissions produced by the baseline scheme and the scheme including the passive energy efficiency measures within the proposed apartments.

Table 7.1 – Predicted energy consumption and CO_2 reductions

Energy use	Floor area	Baseline $C0_2$ emissions (Kg/yr/m^2)	Following energy efficient measures			$C0_2$ reduction (%)
			Total demand (kWh/yr)	Total C02 emissions (Kg/yr)	Total C02 emissions (Kg/yr/m^2)	
Residential						
Gas for space heating	260	11.9	10853.7	2105.6	8.1	31.84
Gas for water heating		7.8	9362.0	1816.2	7.0	10.66
Electricity for space heating (secondary)		2.2	1109.5	468.2	1.8	19.60
Electricity for pumps & fans		0.9	525.0	221.6	0.9	0.00
Electricity for lighting, appliances and cooking		13.6	8362.9	3529.2	13.6	0.00
Total gas demand		**19.7**	**20215.6**	**3921.8**	**15.1**	**23.43**
Total electricity demand		**16.7**	**9997.4**	**4218.9**	**16.3**	**2.63**
Total Site		**36.4**	**30213.0**	**8140.7**	**31.4**	**13.9**

The results show that the reduction in CO_2 emissions following the implementation of passive energy efficiency measures is 1,314 Kg/year, which equates to a reduction of 13.9%.

8 Renewable energy options

Renewable energy can be defined as energy taken from naturally occurring or renewable sources, such as sunlight, wind, waves tides, geothermal etc. Harnessing these energy sources can involve a direct use of natural energy, such as solar water heating panels, or it can be a more indirect process, such as the use of Biofuels produced from plants, which have harnessed and embodied the suns energy through photosynthesis.

This section sets out the feasibility of implementing different energy technologies in consideration of: -

- Potential for Carbon savings;
- Capital costs;
- Running costs;
- Payback period as a result of energy saved;
- Maturity/availability of technology;
- Reliability of the technology and need for back up or alternative systems.

8.1 Wind turbines

In domestic situations such as this wind turbines are used to provide electricity. The power of the wind is used to drive the blades of a propeller, which in turn drives an electrical generator. The electricity produced can either be used directly within the building or sold to the electricity grid.

Wind turbines come in two main types; horizontal axis and vertical axis. The more traditional horizontal axis systems rotate around the central pivot to face into the wind, whilst vertical axis systems work with wind from all directions without having to rotate.

The potential application of wind energy technologies at a particular site is dependent upon a variety of factors. But mainly these are: -

- Wind speed
- Wind turbulence
- Visual impact
- Noise impact
- Impact upon ecology

Initial calculations show that the residential dwellings would require a wind turbine with an output of 2.75kW to provide enough electricity to reduce carbon emissions by approximately 20%.

This assumes that the wind turbine produces around 500kWh/yr per 1kWp of rated power output and an electricity inverter rated at 90% efficient. Based upon these figures a system of 2.75kW (costing around £15,000) would offset 3960 kWh of electricity per year. Assuming that the electricity produced can be sold to the grid at a rate of £0.20 per kWh, a system of this size would pay for itself within around 19 years.

8.2 Solar Energy

The building is orientated roughly east-west and the roof will receive a limited amount of overshadowing from neighbouring buildings or other obstructions. There is scope therefore to site solar photovoltaic or water heating equipment at roof level to face south, but the roof area for this is limited by the relatively small footprint area of the site. The area available is around $60m^2$ on top of the stair overrun.

8.2.1 Photovoltaics (PV)

A 1kWp (1 kilowatt peak) system in the UK could be expected to produce between 700-900 kWh of electricity per year. The area of panelling required to achieve 1kWp is dependent upon the efficiency of the system. Some typical efficiencies and requirements for 1kWp output are given in the following table.

Table 8.1 - Efficiencies and requirements of solar panels

Type of Array	Efficiency	m^2 required to achieve 1kWp	kWh requirement to be met by PV	Area of panel required to meet 20% CO_2 reduction
'Hybrid' silicon cells	18%	$7m^2$	3918	$35m^2$
Mono-crystalline silicon	15%	$8m^2$	3918	$40m^2$
Poly-crystalline silicon	8-12%	$10m^2$	3918	$50m^2$
Amorphous silicon (thin film cells)	4-6%	$20m^2$	3918	$100m^2$

Because the availability of sunlight, to produce electricity, will generally not align with periods of peak demand within the residential sections of the building it is generally more suitable to connect electricity producing systems to the national grid, so that energy can be sold back to suppliers.

Calculations have shown that the residential dwellings would need approximately $35m^2$ of the best performing photovoltaic panels to achieve a 20% reduction in carbon emissions. The system would need to have a peak output of approximately 5kWp and would produce 3918kWh annually.

A system of this size would cost approximately £21,000. Assuming that the electricity produced can be sold to the grid at a rate of £0.20 per kWh, a system of this size would pay for itself in around 27 years.

8.2.2 Solar water heating

Solar water heating panels come in two main types; flat plate collectors and evacuated tubes. Flat plate collectors feed water, or other types of fluid used specifically to carry heat, through a roof mounted collector and into a hot water storage tank. Evacuated tube collectors are slightly more advanced as they employ sealed vacuum tubes, which capture and harness the heat more effectively.

Both collector types can capture heat whether the sky is overcast or clear. Depending on location, approximately 900–1100 kWh of solar energy falls on each m^2 of unshaded UK roof surface annually. The usable energy output per m^2 of solar panel as a result of this amount of insolation ranges from between 380 – 800 kWh/yr.

Solar water heating systems are limited in the amount of heating that they can provide by the availability of sunlight or skylight. Typically, at its most productive, a solar hot water system can replace a third of a dwellings heating requirements.

This means that a solar hot water system on this site is limited to a reduction in CO_2 emissions of around 15%. The table below details the annual hot water and space heating demand, currently provided by gas that would need to be displaced by the solar collectors to reduce the emitted CO_2 by these amounts.

Table 8.2 – Annual output for solar water heating systems

Type of Array	Output from panel (kWh/m2/yr)	Annual kWh requirement to be met by SHW	Area required to meet CO_2 reduction
Residential			
Flat plate collector	380-450	33% or 6671kWh	15 – 17.5m^2
Evacuated tubes	500-800	33% or 6671kWh	8.3 - 13m^2

Assuming a cost of £1000/m^2 the most efficient system would pay for itself within around 74 years.

8.3 Biomass and combined heat and power (CHP)

Biomass is a term given to fuel derived directly from biological sources for example rapeseed oil, wood chip/pellets or gas from anaerobic digestion. It can only be considered as a renewable energy source if the carbon dioxide emitted from burning the fuel is later re-captured in reproducing the fuel source (i.e. trees that are grown to become wood fuel, capture carbon as they grow).

Combined heat and power systems are essentially biomass or fossil fuel fired electricity generators that use the heat by-product to provide space and water heating. The electricity generated can be used directly within the host buildings or sold to electricity suppliers on the national grid. These systems can be employed on a large scale for community schemes or at the micro scale for individual dwellings. However, at present micro scale domestic CHP systems are undergoing testing for effectiveness in the UK and are not readily available on the market.

A large biomass or CHP community system would need a large centralised plant room on the site and potentially a fuel hopper and connected biomass storage room. This space cannot be provided for on the site due to the dense nature of the development and therefore such systems are not feasible.

8.4 Ground source heating

Ground source heating requires a source of consistent ground temperature, which could be a vertical borehole or a spread of pipework loops and a ‘heat pump’. The system uses a loop of fluid to collect the more constant temperature in the ground and transport it to a heat pump. In a cooling system this principle works in reverse and the heat is distributed into the ground.

The heat pump then generates increased temperatures by ‘condensing’ the heat taken from the ground, producing hot water temperatures in the region of 60^{o}C. This water can then be used as pre-heated water for a conventional boiler or to provide space heating with an underfloor heating system.

The use of a ground source heating/cooling system will therefore require:

- Vertical borehole or ground loop
- Use of underfloor heating
- Space for heat pump unit (in addition to a boiler)

The system is powered using electricity and is dependent upon producing more heat energy than electricity consumed. All systems will therefore need a coefficient of performance CoP in excess of 1. E.g. If we consider a system with a CoP of 3.5, it will return 3.5 kilowatts of heat energy for every kilowatt of electricity used.

The drawback of this type of system is that it replaces space heating, which is usually supplied by gas, with an electrical system. Electricity taken from the national grid produces more than twice the CO_2 than does gas burnt in a boiler and is also significantly more expensive per kWh.

There is no open space on the site in which to place a ground loop and it is highly unlikely that it will be feasible to install a borehole system within the existing building. In this case a ground source heat pump is not deemed relevant for assessment.

8.5 Air source heating

Air source heating also employs the principle of a heat pump and works in much the same way as a ground source heat pump. In this case upgrading the ambient external air temperature to provide higher temperatures for water and space heating.

Assuming a seasonal system efficiency of 250% (Coefficient of Performance of 2.5) and that the air source heat pumps will replace 85% of the space heating demand, then the system will reduce the overall CO_2 emissions by approximately 8%.

Based upon these figures this type of system would offset approximately 17,183 kWh of gas energy and would pay for itself within around 43 years, assuming a cost of £6000 per dwelling.

8.6 Renewables summary

Table 8.3 - Summary of feasible renewable energy technologies and related CO_2 reductions

Energy Technology	Unit cost (per unit, kW or m²)	Total cost (£)	Fuel displaced		Payback years	CO_2 reduction (%)	Cost per Kg/CO2
			(kWh/yr)	(£/yr)			
Wind	5500 kW	15125	3960.00	792	19	20.53	482.36
Solar PV (4kWp)	4300 kW	21500	3918.75	783.75	27	20.31	685.67
SHW - Evacuated Tubes	1000 m2	8000	6671.16	108.74	74	15.51	255.13
SHW - Flat plate collectors	1000 m2	8000	6671.16	108.74	74	15.51	255.13
Air source heating	6000 unit	12000	17183.29	280.09	43	8.17	382.70

9 Conclusions

This report has detailed the baseline energy requirements for the proposed development, the reduction in energy demand as a result of energy efficiency measures within the proposed dwellings and the potential to achieve further CO_2 reductions across the site using renewable energy technologies.

The baseline results have shown that if the dwellings were built to meet only the minimum requirements of current building regulations and the commercial units have typical energy uses, the total amount of CO_2 emissions would be 9454 Kg/year.

Following the introduction of passive energy efficiency measures into the dwellings and commercial spaces, as detailed in section 7, the CO_2 emissions from the development will be reduced to 8140 Kg/year a reduction of 14%.

There is also a requirement within the London Plan Policy 4A.7 to reduce CO_2 emissions by a further 20% across the development using renewable or low-carbon energy sources. The report has considered the feasibility of the following technologies:

- Wind turbines
- Solar hot water
- Photovoltaic systems
- Biomass heating
- CHP (Combined heat and power)
- Ground source heating
- Air source heating

The results of the assessment (shown in table 8.3 above) have shown that the use of a Wind Turbine or Solar Photovoltaics could provide a 20% reduction in CO_2 emissions and satisfy the requirements of the London Plan Policy 4A.7 and the London Borough of Camden's Planning Policy.

However, it is unlikely that a wind turbine of this size would be considered acceptable in a dense city centre location like this and solar P.V panels have very large capital costs associated with them.

The most feasible technology in consideration of cost and CO_2 reduction is evacuated tube solar hot water heating. 8 - 13m^2 of tubing would produce enough hot water to replace a third of the residential requirement. This would replace 6671kWh of energy normally provided by natural gas and reduce CO_2 emissions from the residential apartments by 15%.

10 References

London Renewables Toolkit*, Mayor of London, 2004*

Mayor’s energy strategy, *Mayor of London, 2004*

London Borough of Camden’s UDP, *London Borough of Camden, 2006*

A review of microgeneration and renewable energy technologies, NHBC Foundation, *December 2007*

The Government's Standard Assessment Procedure for Energy Rating of Dwellings, *DEFRA, 2008*