Basement Hotel Development at
Great Russell Street, London

Revised Energy Statement

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1	08/04/2013	All	Initial proposals for Energy Statement	P Reid
2	01/08/2013	Header 5,6,9	Changes made as per request by Cunnane Town Planning LLP	P Reid
3	27/11/2013	All	Revised energy strategy proposing air source heat pumps in place of CHP due to thermal profile of building	P Reid
4	27/06/2014	All	Introduction of fresh air from roof level	P Reid

EXECUTIVE SUMMARY

RED Engineering Design has been commissioned to review the energy report 'Planning Strategy Energy Statement for Former NCP Car Park and Proposed New Hotel' at Great Russell Street, London, by White Associates and to modify the report for re-submission as part of the planning application.

The Baseline CO2 emissions are calculated by combining the demands of the proposed building with a set of standard energy supply systems to give the following results :

The baseline CO2 emissions from the notional building are 46kg/m^2/year

Therefore total baseline emissions are 46kg/m^2/year x 6141.7m^2 = 282,518 kg/m^2/year

The planning consent requires that the building energy profile expressed in CO2 emissions is reduced by 20%, by the use of the following features, but, where possible, favouring renewable energy technologies.

The target reduction in CO2 emissions value for the purposes of the planning consent will therefore be **56,504 kg/m^2/year**

This report will investigate and discuss the following aspects in terms of reducing energy usage and CO2 emissions for the new development.

- **Reduction in energy demand**. A description of the design measures which were proposed to maximise the energy efficiency of the development should be provided as part of the energy strategy.
- **Efficient supply of energy**. A description of the analysis undertaken to incorporate decentralised energy network and combined heat and power should be provided as part of the energy strategy.
- **Use of renewable energy**. A description of the analysis undertaken to incorporate renewable energy should be provided as part of the energy strategy.

After implementing the use air source heat pumps in place of gas fired heating systems we are able to achieve the following:

Based on a gas fired system (benchmark building scenario) the heating and hot water generation systems will generate CO2 emissions of **214,753 kg CO_2 / year.**

Using air source heat pumps for the heating and hot water generation would result in the equivalent electrical energy consumption of **242,248 kWh / year.**

This would result in emissions of **126,696 CO_2 / year** and represents a **saving of 88,058 kg of CO_2/year** from the equivalent figure of the bench mark building.

The target reduction in CO_2 emissions based on the baseline emissions is **56,504 kg/year as described in Section 2.2**

The use of air source heat pumps will therefore provide a CO2 emissions saving of 31.2% and as such will exceed the local authority requirement to reduce the CO_2 emissions of the notional (benchmark) building by more than 20%

Due to the constraints of the site we cannot implement any other 'bolt on' technologies such as photovoltaics or solar hot water.

We recommend the implementation of LED lighting, air source heat pumps and heat recovery ventilation – making a low carbon impact on each element of the fixed building services.

Based on studies within other areas of central London, the ability to connect to future district energy networks would provide an additional 5 to 10% of CO_2 reductions giving an overall saving of 36% to 41% from the CO_2 emissions of the benchmark building.

As directed by the Camden Borough Council Planning Department, all incoming fresh air for the new development will be taken from roof level and ducted to air handling units in the basement. Vitiated extract air will be routed through existing ducts and discharge to street level as at present.

CONTENTS

1.0 INTRODUCTION TO PLANNING REQUIREMENTS

White Associates Environmental Engineers Ltd was originally commissioned by GRS Limited to carry out a fully comprehensive report to provide an analysis of the possible sustainable energy generation and passive methods available for the new proposed hotel at the NCP Great Russell Street development in order to comply with The London Plan. The development is for a 172 bedroom hotel located within what is currently an existing subterranean NCP car park, set over two levels.

RED Engineering Design has been commissioned to review the energy report 'Planning Strategy Energy Statement for Former NCP Car Park and Proposed New Hotel' at Great Russell Street, London, by White Associates and to modify the report for re-submission as part of the planning application.

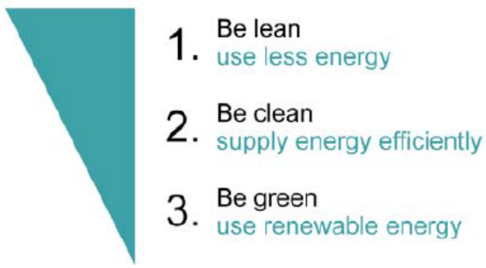
The previously submitted planning strategy energy report did not fully address the Camden Planning Guidance, Sustainability, CPG3 and therefore did not fully address the planning conditions as stipulated by Camden Borough Council with regards to energy and water.

1.1 Camden Planning Guidance – Sustainability – CPG3 Requirements

1.1.1 Energy Strategy

The following excerpts are taken from the Camden Planning Guidance, Sustainability, CPG3, section 2.0 "The energy hierarchy":

"All developments are expected to reduce their carbon dioxide emissions by following the steps in the energy hierarchy to reduce energy consumption."



"Developments involving 5 or more dwellings and/or 500sq m (gross internal) floorspace or more are required to submit an energy statement which demonstrates how carbon dioxide emissions will be reduced in line with the energy hierarchy"

Therefore, the Council will be expecting within the energy statement the following sections as outlined per CPG3 section 2.6:

- **Baseline energy demand and carbon dioxide emissions.** The baseline energy demand of the development and the corresponding carbon dioxide emissions arising from the development should be calculated. The methodology should be clearly demonstrated as part of the calculation.
- **Reduction in energy demand**. A description of the design measures which were proposed to maximise the energy efficiency of the development should be provided as part of the energy strategy.
- **Efficient supply of energy**. A description of the analysis undertaken to incorporate decentralised energy network and combined heat and power should be provided as part of the energy strategy.
- Analysis of the energy use and the corresponding carbon dioxide emissions from the development having applied the first two stages of the energy hierarchy (Reduction in energy demand + Efficient supply of energy).

- **Use of renewable energy**. A description of the analysis undertaken to incorporate renewable energy should be provided as part of the energy strategy.
- Analysis of energy use and the corresponding carbon dioxide emissions from the development having applied all three stages of the energy hierarchy.

Furthermore, in accordance to the following excerpt from section 6.0 "Renewable Energy":

"Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies."

The following is a list of approved renewable energy technologies as outlined in CPG3:

- Solar/thermal hot water panels
- Photovoltaic
- Ground source heat pumps (GSHP) or geothermal
- Air source heat pumps (ASHP)
- Biomass heating and power
- Wind turbines

1.1.2 Water Strategy

The following excerpts are taken from the Camden Planning Guidance, Sustainability, CPG3, section 7.0 "Water efficiency":

"At least 50% of water consumed in homes and workplaces does not need to be of drinkable quality re-using water."

The Council will require developments over 10 units or 1000sq m and/or intense water use developments, such as hotels, hostels, student housing etc to include a grey water harvesting system, unless the applicant demonstrates to the Council's satisfaction that this is not feasible.

1.1.2.1 Minimising water use

The Council will be expecting a range of the following measures to be used in the development in order to minimise water use:

- Dual flush toilets;
- Low flow taps and shower heads; and
- Low water consuming washing machines and dishwashers.

1.1.2.2 Maximising the re-use of water

The council will be expecting a feasibility study for grey water systems addressing the following areas:

- The cost of the system;
- Cost savings for owner/occupier over a 10 year period;
- Projected grey water generation;
- Projected demand for use of grey water; and
- Water savings as a result of the grey water system.

1.2 Structure of Report

This report comprises a number of sections that together provide a review of the energy report previously submitted to Camden Borough Council.

This section provides an introduction to the project and sets out the objectives with respect of developing an energy and water strategy for compliance with planning conditions in accordance with Camden Borough Council Planning Services requirements.

Section 2 covers the calculation of the Building energy modelling results and defines the associated targets for the purposes of the energy strategy.

Section 3 discusses the various technologies available divided into sub-sections for passive energy reducing measures, energy efficient technologies, local generation and renewable energy technologies.

Section 4 describes the mechanical services concept design

Section 5 The conclusion drawn from this report is presented in this section.

2.0 ESTABLISHING ENERGY BENCHMARKS

White Associates Environmental Engineers Ltd has been previously commissioned to carry out an energy strategy for the new proposed hotel at NCP Great Russell Street.

As highlighted in section 1.0 of this report, all developments with a floor space of 500m^2 or more are required to submit an energy statement which demonstrates how carbon dioxide emissions will be reduced in line with the energy hierarchy.

The estimated floor space of the proposed development has been found to be around 5,267m^2 as stated per the energy report produced by White Associates Ltd; therefore the energy strategy report should address each of the areas highlighted in section 1.1.1 of this report as per CPG3.

2.1 Baseline Energy Demand and Carbon Dioxide Emissions

The first requirement of the energy strategy as per CPG3 is the calculations of the baseline energy demand and Carbon Dioxide emissions of the development. Furthermore, as per CPG3 the calculations should show the energy demand and carbon dioxide emissions including and excluding unregulated loads.
iSBEM has been used to generate the baseline outputs, as produced in the report by White Associates Ltd.

2.2 Estimated Figures as taken from the original White Associates report

The estimated baseline demands used in this assessment are based on the results from the iSBEM calculations carried out by White Associates. Using this methodology, the final estimated energy demands for the hotel were as follows:

Space Heating : 281,995 kWh/yr
Hot Water : 808,125 kWh/yr
Electrical : 322,316 kWh/yr
Cooling : 614.7 kWh/yr

Total energy load 1,413,051 kWh/yr

Baseline CO2 emissions

The Baseline CO2 emissions were calculated by combining the demands in section 7.1 of the SBEM BRUKL output with a set of standard energy supply systems as follows. There are no solar gains to the building hence the very low cooling load, which will be formed from latent loads such as people and ventilation loads. By introducing a continuous variable air change rate based on air quality and temperature, these loads will be eliminated as part of the ventilation strategy.

The baseline CO2 emissions from the notional building are 46kg/m^2/year

Therefore total baseline emissions are 46kg/m^2/year x 6141.7m^2 = 282,518 kg/year

The target reduction in CO2 emissions value for the purposes of the planning consent will be **56,504 kg/year**

3.0 PROPOSED METHODS OF REDUCTING ENERGY LOADS

3.1 Reduction of Energy Consumption

The second requirement of the energy strategy as per CPG3 is stage 1 of the energy hierarchy *'Be lean'*. In this section of the energy strategy the council is expecting to see the following areas addressed as per section 4.0 of CPG3:

- Natural systems (e.g.: preventing overheating, natural ventilation, etc…)
- Thermal performance (e.g.: U-value, air tightness, etc…)
- Mechanical systems (e.g.: MVHR, avoiding electric heating systems, etc…)
- Other energy efficient technology (e.g.: high efficiency lighting with controlled sensors, building management system, etc…)

3.1.1 Passive Energy Reduction Measures

Local Weather and Microclimate
There is no effect from the external environment to the fabric heat losses or heat gains for this scheme as it is 4 and 5 storeys below ground level, unaffected by the weather.

Built Form
The internal partitioning between the external ground and internal spaces will be to a high thermal efficiency to prevent unwanted heat loss or gain from the ground. U-Values for all walls to the external edges will be a maximum of 0.25 W/m2K

Windows and Glazing
The only glazing on the scheme will be the reception area on the ground floor level. This will be of a U-value which is better than the building regulations minimum standard requirement.

Control of Unwanted Ventilation
Part L2A of the Building Regulations calls for measures to minimise air leakage in non-domestic buildings.
The new hotel will be constructed to achieve an air permeability of 5m3/m2/hr
The building fabric will be designed and built to be as airtight as possible to take advantage of a well-designed ventilation strategy. 'Build tight, ventilate right' is true for both mechanical and naturally ventilated buildings.

Integrating Services
Efficient design will ensure that the services operate in harmony and without detrimental conflict with other services. Careful attention with control of lighting will determine the amount of heat gain to internal environment.

Minimising Requirements for Services
The design of the services shall be such that over-design is limited. Over-design can contribute significantly to capital and running costs. Reducing the complexity of the services will also improve energy efficiency.
Important factors that will influence the performance specification and calculations will be:
• Reducing the design margins down to a minimum,
• Relaxing the design parameters to allow greater operating ranges,

Minimising plant sophistication,
Designing to ensure that energy efficiency does not result in high running costs.

Optimising Daylighting
Daylighting is a major part of the overall lighting design strategy in most buildings, but unfortunately as the hotel is subterranean there is no scope for maximising or optimising daylighting.

Minimising Distribution Losses
Consideration will also be given to minimising distribution lengths of pipework by siting of pumps and fans as near to the loads as possible will reduce transport losses.
These transport losses will be influenced by the following factors:-

- The location of plant rooms
- The provision of space for distribution

Additional energy efficiencies will be achieved by reducing unnecessary pressure drops in the system by the careful sizing, routing and detailing of ductwork and pipework.

Manageability
The design of building services will ensure that systems should default to 'off' or 'standby', and not allowed to by-pass or be left on continuously, they will also operate robustly, rapidly and predictably, giving intelligible responses - especially during intense use. Good ergonomic design, rapid feedback and clear diagnostics will be essential features and not optional extras.

Maintainability
The design of the building services will consider ease of maintenance, which will have influence of future energy efficiency. The requirements of space, position, access, repair and replacement of services will be considered so that equipment can be commissioned, monitored and maintained. There will be the ability to check or change features such as set points, control authority, filter elements, etc.

The specification will include a properly planned operating and maintenance procedures so that design targets for the minimum use of energy are achieved

3.1.2 Mixed Mode Ventilation

'Mixed mode' is a term used to describe servicing strategies that combine natural ventilation with mechanical ventilation and/or cooling in the most effective manner. It involves maximising the use of the building fabric and envelope to achieve indoor environmental conditions, and then supplementing this with degrees of mechanical systems, in all or parts of the building. To date the approach has been used most widely in offices; however it is suitable for a wide range of building types.

The mixed mode options for this development are very limited as the access to natural ventilation is severely restricted with all areas being below ground level.

3.1.3 Heat Recovery

Air to air heat recovery can carried out in a number of ways, the most common being Run-around coils, plate heat exchangers and Thermal Wheel heat recuperators.

Typical year round average efficiencies are 55% for plate heat exchangers and 80% for Thermal Wheels. Runaround coils have efficiencies of typically less than 30% under most conditions.

We would propose that the ventilation units incorporate thermal wheels in order to reduce the heating and cooling loads resulting for the air changes in the building.

3.1.4 Variable Speed Drives

Each 10% in reduction of a fan speed will result in an energy reduction of around 27% in terms of electricity consumption. We therefore recommend that all air handling unit fans are fitted with motors which are inverter controlled depending on the demand on the system as dictated by temperature and air quality parameters measured at different parts of the building.

3.1.5 Lighting Design

Although there is no scope for any natural daylight harvesting, we would recommend that either LEDs or high efficiency fluorescent fittings are specified throughout. Furthermore, PIRs should be provided in all applicable areas including stores, public WC's, corridors, etc.

3.2 On Site Generation

The second requirement of the energy strategy as per CPG3 is stage 2 of the energy hierarchy *'Be Clean'*. In this section of the energy strategy the council is expecting to see the following areas addressed as per section 5.0 of CPG3:

- Investigating the potential for connecting into an existing or planned decentralised energy scheme
- Investigating the potential of on-site combined heat and power

3.2.1 Investigating the potential for connecting into an existing or planned decentralised energy scheme

As per CPG3 section 5.0 proposed developments are expected to investigate potential connections to proposed or existing district heating network scheme. Furthermore, section 5.17 and 5.18 of the CPG3 documents outlines the expected analysis from the Council if a proposed or existing district heating network scheme is within a 1km (section 5.17 of CPG3) or 500m (section 5.18 of CPG3) of a potential district heating network.

As it can be seen in the image below from the London Heat Map, there are three potential networks surrounding the proposed developments two of them are existing and running, however, they are at a proximity of 1.4km and 1.9km, therefore, as per CPG3 section 5.0 they don't need to be addressed as part of the energy strategy. However, there is a proposed network alongside Euston Road and it is at an estimated proximity of 1km of the proposed development, therefore, it needs to be addressed as per section 5.17 of CPG3.

3.2.2 Investigating the potential of on-site combined heat and power

Cogeneration, also known as Combined Heat and Power (CHP), is the production of heat and power from a single energy source. It is the most efficient way of generating electricity and heat. A cogeneration unit is a self-contained power station and boiler combined in a single machine using a single fuel.

The basic elements of a CHP plant comprise one or more prime movers usually driving electrical generators, where the heat generated in the process is utilised via suitable heat recovery equipment for a variety of purposes including: industrial processes, community heating and space heating.

CHP can provide a secure and highly efficient method of generating electricity and heat at the point of use. Due to the utilisation of heat from electricity generation and the avoidance of transmission losses because electricity is generated on site, CHP typically achieves a 35 per cent reduction in primary energy usage compared with power stations and heat only boilers.

When considering CHP, savings are achieved because the value of the electricity and heat produced is greater than the cost of operation, i.e. the fuel consumed and the plant maintenance. The economic viability of CHP is dependent on the demand for heat and power, and it is essential that detailed energy demand profiles for both heat and electricity are produced to allow accurate sizing of the CHP plant and hence assess its suitability for use in each case. In order to achieve maximum returns, the CHP plant must operate for as many hours as possible, which means matching CHP capacity to base heating and power loads.

Using a CHP unit, we are able to offset a percentage of the electrical usage in the hotel for the ventilation and lighting loads, as long as this is balanced with the thermal demand from the hot water as there is a relatively low heating demand. Flues on micro CHP units can discharge at low level making this a feasible proposal.

In regards of section 3, according to “DOE 1993, Energy Consumption Guide 36: Energy efficiency in hotels - A guide for owners and Managers. Energy Efficiency Best Practice programme”, it is safe to assume for hotels 109 kWh/m^2 of fossil fuel use (assuming a heat source efficiency of 88%) in order to estimate the DHW consumption

Therefore in our case, 109 (kWh/m2) x 6,148 (m2) = 670,132 kWh per year

which equates to

670,132 / 8760 = **76kW average DHW** demand throughout the year.

However, the hotel has no catering, leisure or conference facilities and therefore due to the low constant thermal demand of the building, we do not consider that the use of a CHP would be as beneficial as other technologies in terms of reducing CO2 emissions for this particular site.

3.2.3 Summary of the requirements

The following is a summary of the requirements as to what the council is expecting in order to meet the requirements of CPG3 in terms of efficient supply of energy:

- the installation of CHP/CCHP and the generation and use of energy if viable
- details that ensure the plant and its operation is carbon dioxide efficient with regards to operating hours, compatibility with the need (amount and timing) for heat, and requirements for a heat store
- details that ensure the design of the heating system is compatible with any nearby decentralised energy network
- the export of heat, cooling and/or electricity
- development use heat, cooling and or electricity from a decentralised energy network, including by entering into a long term energy contract
- sufficient space is provided for future plant, heat exchanges, connection points to either generate, export and take heat, cooling and/or electricity
- a financial contribution towards future decentralised energy networks

3.3 Renewable Energy Technologies

3.3.1 Ground Source Heat Pumps

The earth is our largest solar collector and heat storage facility. While ambient temperatures in the UK vary between -4^{o}C and 30^{o}C throughout the year, the temperature just 3m to 4m below the earth's surface remains relatively constant - between 10.5^{o}C and 11.5^{o}C.

Ground source heat pumps utilise this feature, using the energy stored in the ground to provide highly efficient heating and cooling systems. Average coefficient of performances for ground source heat pumps is 5.

A ground source heat pump application consists of pipes running into the ground from the building. Water from the building's heating and cooling system flows through the pipes.

Depending on the season, this water is either warmed or cooled before returning to the heating/cooling system.

Ground Source Cooling is only applicable where a building has a cooling demand and where there is access to suitable ground. Ground sourced cooling systems cannot generally be seen from the outside of the building so aesthetic design is not an issue.

For new buildings where there is limited space, it is possible to use the building piles to house the closed loop pipework. The loops are attached to the piling cage, taken to site and put in place. Cement is poured into the cage, with the loops under pressure to ensure no leaks when the cement sets. This also means that no ground drilling is required to house the closed loop.

Some buildings may have access to an underground water source, or aquifer. If this is the case, an open loop system can be used. A borehole runs under the building, down to the aquifer. Water is pumped up from this source, and travels across a plate heat exchanger into the building's heating/cooling system. After travelling through the building, the water is ejected back into the aquifer. There are regulations outlining how far apart the extraction and rejection tubes have to be placed (approximately 100m).

There are two main types of piping: closed loop or open loop, with variations on each. One closed loop ground source system consists of a series of vertical U tubes, made from high density polyethylene pipe. This is placed in a 100mm diameter borehole, with a silica and Benonite sand mix. Alternatively, the pipes can run horizontally, in a continuous spiral form, known as a 'slinky'.

Closed loops can be buried under buildings and car parks, with no detriment to the operation. Loop capacities range from 6kW to 10,000 kW. It is a low maintenance technology, with a 50 to 75 year life expectancy.

Technical Feasibility Issues or Constraints
It would be impossible to break through the existing ground floor slab, and even if this were managed – it would not be possible to get a boring rig into the tight confines of the car park.

Maintenance Requirements
There are no specific maintenance problems with ground cooling systems, except to keep pipes and pumps clear where ground water is used directly. General equipment maintenance will be less than with the use of traditional electrically driven chillers.

Additional Benefits of Technology
There will be significant running cost savings from the use of ground cooling compared with conventional chillers, as the only energy use is in pumping the water from the ground or round the buried pipe system. A 90% saving in energy use for supply of cooled water can be achieved by effective ground systems. There may also be locational benefits in that conventional chilling plant is normally located on the roof or top storey of the building, whilst ground water pumping will use a basement. This may allow the upper area to be occupied and the visual intrusion of roof plant avoided, while use is made of the less attractive underground space.

Planning and Legislative Issues
Ground sourced cooling cannot be seen from the outside of the building and so should not be an issue for planners when looking at the aesthetics of a potential development. Permission is however likely to be required for ground drilling or bore hole use. For an open system, the process of applying for a groundwater license begins with gaining consent from the Environment Agency to drill and investigate a borehole.

CONCLUSION
The site is an existing subterranean car park and it would be impractical to break through the existing slab into the ground.

3.3.2 Wind Turbines

Wind energy is one of the most cost effective methods of renewable power generation. Wind turbines can produce electricity without carbon dioxide emissions ranging from watts to megawatt outputs. The most conventional design is for three blades mounted on a horizontal axis, which is free to rotate into the wind on a tall tower.

The blades drive a generator either directly or via a gearbox (generally for larger machines) to generate electricity. The electricity can either be linked into the grid or charge batteries. An inverter is essential to convert the electricity from Direct Current (DC) to alternating current (AC) for feeding into the grid.

Modern quiet wind turbines are presentable in low density areas, where ease of maintenance and immediate connection to the grid. Wind turbines are generally inappropriate in dense urban areas as their output will be affected by potentially lower and more disrupted wind speeds, and the use of larger more cost effective machines may be prohibited by their proximity to some building types.

Miniature turbines can also be mounted on buildings. There are currently few practical installations of roof mounted wind turbines in the UK but it is imminent that this will be a growing market and a number of companies are marketing small roof mounted turbines.

Potential public resistance has restricted the use of large-scale wind turbines (above 50kW) although studies demonstrate that in general the local perceptions of wind farms/turbines improve once it has been assembled.

Output Ranges
Wind turbines are available with outputs ranging from 600W to 3.6MW. The main factor affecting the productivity of wind turbines is the average wind speed. This varies for different areas of the UK but increases with the height of the turbine above ground level. Local topography can significantly impact upon local wind speeds. A small difference in wind speed will make a large difference to output.

Issues to be taken into consideration include:
• The average wind speed at the site. Currently the BWEA suggests a large wind turbine to be viable where wind speed is 7m/s or above. However turbines will operate from a wind speed of 4m/s and produce useful quantity of energy.
• The changeable and turbulent wind patterns that occur near buildings and other obstacles.
• The requirement for planning consent.
The best practice for a developer is to speak to the local planning authority at the earliest convenience to contemplate any objections to the proposal, which cannot be negotiated. However, the planning office may also indicate key issues of concern from which a judgment can be made on how to deal with the proposal in terms of the design, location, size and scale of the project.

The potential visual impact on important public viewpoints and on local ecology should also be assessed.

Any landscape designates (such as AONB or SSSI) and Conservation Areas. See the British Wind Association's27 Best Practice Guidelines for Wind Energy Development for further guidance.

Workable noise from the turbines (although modern turbines without gearboxes are quiet and are said to be drowned out by a passing cars).

The attainable space for a turbine, as this must be positioned at a minimum distance from residential and school buildings due to noise, reflected light and shadow flicker, which varies according to their height.
Some turbine blades come in different colours. The colour could be chosen to enhance the appearance of the turbine or make it as inconspicuous as possible (if this was the desired outcome).

Maintenance Requirements
There are very few maintenance requirements - services check every 2 years would be advisable. A wind turbine typically lasts 20-25 years.

Additional Benefits of Technology
These are one of the more cost effective of the obtainable renewable technologies.
There could be significant green marketing opportunities.

Planning and Legislative Issues
Planning permission will be appropriate for each location. If the proposed site for larger wind turbines (above 50kW) is in Greenbelt or Metropolitan Open Land, demonstration of 'very special circumstances' will be required to obtain planning permission. See Planning Policy Guidance 2: Green Belts28 for further details.

The potential impact of noise pollution from turbine blades, mechanical components and any linked structures should be premeditated. This includes structure-borne vibration if turbines are building-mounted. Modern turbines can be much quieter than earlier models, and variation in size, design and performance means that specifying universally applicable distances from housing, schools or other noise-sensitive receptors has become inappropriate. Variations in local background noise also mean that proposals need to be assessed in relation to local circumstances.

Particular attention should be made to how turbine noise compares with background noise during quieter periods, particularly at night (2300-0700) and in situations where receptors and turbines may sometimes be in contrasting wind-noise conditions.

CONCLUSION
The installation of a Wind Turbine could potentially enable a CO2 saving, wind could be used as part of a portfolio of renewables to help meet the targets, however due to the fact the client does not own the building above the car park we would not get permission to site them on the roof.

3.3.3 Photovoltaics

Photovoltaic systems transform energy from the sun into electricity through semi-conductor cells. The semi-conductor cells are connected in succession and mounted into modules. The modules are connected to an inverter to turn their direct current (DC) output into alternating current (AC) electricity for use in buildings.

Photovoltaic's supply electricity to the building they are dedicated to or to any other load connected to the electricity grid. Excess electricity can be sold to the National Grid when the generated power exceeds the local need. Photovoltaic systems only require daylight, not sunlight to generate electricity (although more electricity is produced with more sunlight), so energy can still be produced in overcast or cloudy conditions.

Photovoltaic panels come in modular panels which can be fitted to the top of roofs (looking similar to a roof light) and in slates or shingles which are an integral part of the roof covering (looking similar to normal roof tiles). Photovoltaic cells can be incorporated into glass for atria walls and roofs or used as cladding or rain screen on a building wall.

Ideally photovoltaics should face between south-east and south-west, at an elevation of about 30-40°. However, in the UK even flat roofs receive 90% of the energy of an optimum system. They are particularly suited to buildings that use electricity during the day - offices, retail and schools.

Output Ranges
As a rule of thumb a typical Photovoltaics installation can provide 110kWh per year per m2 based on a Monocrystalline array(assuming a reasonable tilt, orientation and system efficiency), however the proposed Sunchaser system manufactured by Schuco provides 524kWh per year per m2.

The effectiveness depends more on location, orientation and whole system design than it does on cell type. Photovoltaic cells come in a number of types with varying operating efficiencies and consequently various sizes of panel are imperative to generate the comparable output.

Technical Feasibility Issues or Constraints

- Photovoltaics should ideally be positioned between south-east and south-west orientation, at an elevation of about 30-40° although arrays pointing east or west are passable (albeit at lower performance) especially for roofs inclined at a low angle to the horizontal.
- Arrays should NOT be horizontal as the rain will be unable to wash them clean.
- Systems should be in locations that will be un-shaded at all times of day if possible. Gable roofs, chimneys, cables, TV aerials, trees and other buildings in the vicinity should be identified as potentially shading the modules, particularly in the early morning or early afternoon. The performance of a whole panel will be affected even if only part of it is shaded.
- Photovoltaics need to be ventilated (behind the modules) so that they don't increase in temperature, their efficiency decreases as their temperature rises. Suitable ventilation is easier to ensure for bolt-on systems. Rear ventilation is less important for some thin film modules, which can be mounted directly onto the roof cover.

- The possibility of sabotage should be assessed, if the system is visible from the ground or if it is accessible due to raised pavements or other buildings. Occasionally it is inescapable to cover panels with heavy duty Perspex to protect them from flying objects.

Maintenance Requirements
There should be minimal maintenance required as the technology has no moving parts. If there is a large bird migration in the area, they should be discouraged from perching on or near the photovoltaic cells as quantities of bird excrement on the panels will affect their performance. Bird excrement is unlikely to be washed away by rain.

The output of the panel should be monitored so that if the output is much lower than expected, the panels and set up can be inspected and if necessary cleaned.

Additional Benefits of Technology
The two main benefits of integrating photovoltaics into a development are the production of free electricity and the resulting saving of carbon emissions. As a technology it also has a number of other benefits:

- Straightforward to install as modular and light.
- Technically reliable - they are generally guaranteed to last between 20 years but are anticipated to last longer.
- Avoidance of climate change levy for non-domestic buildings.
- Architectural integration – photovoltaics can be added almost invisibly to buildings, can be used as a design element or can lead the architectural concept of a building
- Marketing impact - a clear statement about renewable energy
- Excess electricity can be sold to the grid. The costs received will need to be negotiated with an energy supplier
- Monies can be saved where the Photovoltaic's panels displace other construction materials such as roof tiles, or prestige cladding materials such as marble
- Renewable Obligation Certificates, or Renewable Energy Certificates of Origin can be obtained depending on the amount of electricity

Planning and Legislative issues
There are no licensing requirements relating to photovoltaic systems, nevertheless the consent of the local Distribution Network Operator (DNO) is required to connect the system to the grid.

Single installations of small photovoltaic systems (up to 5kW) will come under the scope of Engineering Recommendation G83/1 - 'Recommendations for the connection of small-scale embedded generators (up to 16amps per phase) in parallel with public low-voltage distribution networks'.

Larger systems (above 5kW) and multiple small systems are expected to meet Engineering Recommendation G59 - 'Recommendations for the connection of embedded generating plant to the regional companies' distribution systems.

CONCLUSION
The installation of photovoltaics is not a viable option as the client does not have any roof-space to install them on.

3.4 Energy Demand and Carbon Dioxide Emissions for the First Two Stages of the Energy Hierarchy

The fourth requirement of the energy strategy as per CPG3 is the calculation of the energy demand and carbon dioxide emissions for the first two stages of the energy hierarchy. Similarly to the baseline calculations, this should show the outputs for the calculations including and excluding the unregulated loads.

In the reviewed energy strategy report a section needs to be created in order to address this issue. The report as it currently stands presents the calculations in the conclusions without having outlined the 'be lean' and 'be clean' strategies as per CPG3. Furthermore, the outputs should be shown including and excluding unregulated loads.

3.5 Use of renewable energy

The fifth requirement of the energy strategy as per CPG3 is stage 3 of the energy hierarchy *'Be Green'*. In this section of the energy strategy the council is expecting to see 20% reduction in carbon dioxide emissions from on-site renewable energy technologies, the following is a list of approved technologies as per CPG3 section 6.0:

- Solar/thermal hot water panels
- Photovoltaic
- Ground source heat pumps (GSHP) or geothermal
- Air source heat pumps (ASHP)
- Biomass heating and power
- Wind turbines

4.0 CONCEPT DESIGN OUTLINE PROPOSAL

In order for the building services to provide the necessary energy efficiency to comply with the estimated CO2 emissions reductions, we propose that the following features are incorporated into the MEP design :

Air handling units provided with thermal wheel heat recovery features. The air handling units would be located at each of the room levels on the existing car park ramps underneath the Bedford Street elevation. Incoming fresh air for the air handling units would be routed from roof level down an existing vertical duct where it would enter the YMCA, then connect to new ductwork to run across at high level to exit the building below ground and drop to each basement level within an existing fire ventilation duct beneath the pavement on Tottenham Court Road. It is not envisaged at this stage that any fan will be required on the roof; instead the basement air handling unit fans will need to be sized to account for the higher than usual pressure drop in the inlet ductwork.

The vitiated air from the rooms would be extracted by the same air handling units and then discharged through the existing car park extract ducts to high level louvres on the street.

Variable speed drives to control all fan motors witch connections to BEMS and temperature/air quality sensors.

Use of LED and high efficiency fluorescent lighting.

PIR movement controls for lighting.

Variable Refrigeration Volume (VRV) Air source heat pumps for hot water generation, heating and cooling. The external condensing units for this would be located in the plant area adjacent to the refuse store at street level on the Adeline Place elevation.

Interface and available plant space for future connection to a district energy scheme.

5.0 CONCLUSION

This report has been based on the original calculations submitted by White Associates for energy reduction, local generation and renewable energy technologies to provide estimates for the benchmark building and the savings achieved by using these technologies.

This document has assessed the different carbon reducing technologies available for the development of a new hotel within the basement NCP car park at Great Russell Street, which sits between Tottenham Court Road and Bedford Square. The scheme is somewhat unique in that it is located 4 and 5 storeys below ground.

It will have no impact from solar gains, nor will it have the level of heat losses attributed to exposed facades. Its position also severely restricts the building services provisions which one would normally consider for an above-ground development.

There are existing buildings, primarily the YMCA headquarters – located above – and no access to the roof is possible. This rules out two of the main technologies we would consider viable in some circumstances – photovoltaics and solar hot water. There is no permitted connection route through other demises to the roof.

The local authority has insisted that fresh incoming air cannot be taken from street level and therefore, a scheme has been proposed whereby fresh air is brought in from the top roof level and routed down new and existing ducts to connect to the inlet side of the air handling units at each of the basement room levels.

We are therefore left with very limited solutions to our obligation for a 20% reduction in carbon emissions.

Without two of the major renewable technologies we are left with the options for biomass and wind turbines.

Wind turbines are again a roof mounted solution, which is not viable as we have no roof in our demise and Biomass comes with a number or problems for a site such as this; delivery would be problematic in central London, as would the installation of a flue for any type biomass boiler in such a location, without access to the roof.

As the development is not affected by external conditions, we have a number of fixed loads for energy consumption:
Lighting – fixed load as no windows
Heating – minimal fixed load as no exposed facade for heat losses
Cooling – internal gains from lighting and equipment, and people only.
Ventilation – internal rooms need continuous ventilation both supply and extract to comply with Building Regulations Part F

It is therefore very clear that the main method of reducing energy usage is through the design of the building services. If we can install services which minimise energy usage, and recover heating or cooling as part of their design then we can minimise the electrical and thermal demands.

Due to the nature of this site, we are proposing to install

Whilst the hot water demand will fluctuate, it will average at around 80kW per day, and this will be addressed by the use of air source heat pumps using higher condensing temperatures to provide domestic hot water at 60^{O}C.

We intend to provide a highly efficient heat recovery ventilation system using a thermal wheel which will provide tempered air via DX coil connected to an air source heat pump. The system will be able to provide a fixed temperature of air by recovering around 75% of the heat from the extract system, then providing heating or cooling as necessary to maintain a steady state condition internally.

Individual room temperature control will be achieved by the use of air source heat pumps serving dedicated indoor fan coil units to allow for local heat gains and losses.

The BRUKL results show that the carbon savings from implementing these improvements to the M&E services will reduce carbon emissions by the following amount:

The baseline CO2 emissions from the notional building are 46kg/m^2/year

Therefore total baseline emissions are 46kg CO_2 /m^2/year x 6141.7m^2 = **282,518 kg CO_2/year**

The total energy consumption of the building associated with space heating is 281,995 kWh/yr

The total energy consumption of the building associated with Hot Water generation is 808,125 kWh/yr

Based on a gas fired system, this represents a total CO2 emissions figure of (281,995 +808,125) x 0.197 = **214,753 kg CO_2 / yr.**

With an average heat pump seasonal efficiency of 4.5, the equivalent electrical consumption of these units would be (281,995 +808,125) / 4.5 = **242,248 kWh / yr.**

This is the equivalent of 242248 x 0.523 = 126,696 CO_2 / yr. This represents a **saving of 88,058 kg of CO_2/yr** from the equivalent figure of the bench mark building.

The target reduction in CO_2 emissions based on the baseline emissions is **56,504 kg/year as described in Section 2.2**

The use of air source heat pumps will therefore exceed the local authority requirement to reduce the CO_2 emissions of the notional (benchmark) building by more than 20%

We have implemented LED lighting, air source heat pumps and heat recovery ventilation – making a low carbon impact on each element of the fixed building services. We believe it may well be possible to achieve a better air permeability result than 10 m3/m2/hr @50Pa, and if this actually tests to anything below 6 we will achieve additional reduction in the building CO_2 emissions – however as the building is existing and we are constructing our site within it, we cannot guarantee this until we are in detailed design stages.

However, based on studies within other areas of central London, the ability to connect to future district energy networks will provide an additional 5 to 10% of CO_2 reductions giving an overall saving of 36% to 41% from the CO_2 emissions of the benchmark building once this has been implemented.