PROPOSED HOTEL CONVERSION

203 HIGH HOLBORN
LONDON WC1V 7BD

ENERGY AND SUSTAINABILITY STRATEGY

SEPTEMBER 2011

EDISTON OPPORTUNITY FUND

Premier Inn

CONTENTS

1.0 EXECUTIVE SUMMARY

This energy and sustainability assessment has been prepared on behalf of Ediston Opportunity Fund for the proposed conversion of the existing offices at 203 High Holborn, London to a 138 bedroom hotel with restaurant facilities.

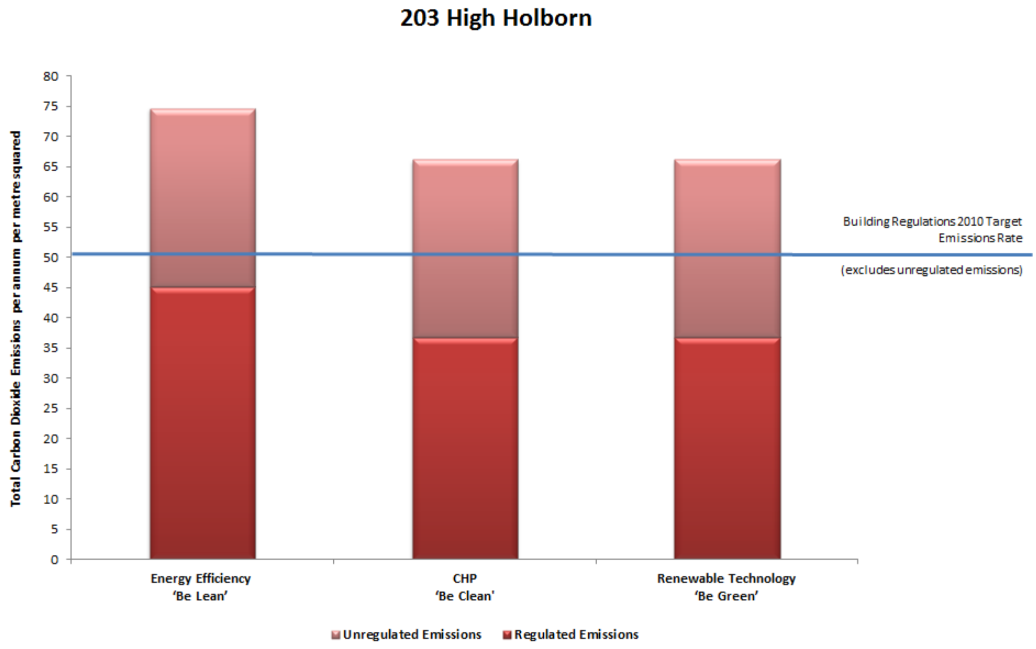
With the site situated in the London Borough of Camden, this report will take account of the guidance given in national and regional planning policies in addition to those of the London Borough of Camden to provide an energy efficient and sustainable building.

This assessment will demonstrate that the proposed scheme will improve the sustainability and environmental performance of London's built environment by improving energy efficiency, reducing carbon dioxide emissions, generating energy services efficiently and implementing building integrated low carbon technologies.

The table below illustrates the CO_2 emissions reduction for each step taken through the energy design process and show how the proposed building meets requirements detailed in The London Plan 2011. As set out below, the development achieves a total reduction in CO_2 emissions of 27.0% against the new and improved 2010 Building Regulations Target Emissions Rate (TER) through the inclusion of low and zero carbon (LZC) technologies.

203 High Holborn	CO_2 Emissions ($kg\ CO_2/yr/m^2$)	% Improvement CO_2 Emissions Over TER
Target Emissions Rate (TER)	50.3	-
'Be Lean' – Energy Efficiency	45.2	10.1%
'Be Clean' – Gas Fired CHP	36.7	27.0%
'Be Green' - Renewables	-	-

Table 1: CO_2 Emissions – Scheme Comparison



Graph 1: Scheme CO_2 Emissions

The proposed design will not only improve on the existing building services systems installed, but will also aim to exceed Part L 2010 Building Regulations requirements for energy performance by improving energy efficiency and following the *'Be Lean'* strategy. These measures, which include the use of air source heat pumps (ASHP) incorporating heat recovery, are estimated to result in a 10.1% reduction in CO_2 emissions compared to TER.

In keeping with the *'Be Clean'* philosophy of the London Plan guidance, the energy hierarchy has been reviewed and it is proposed that a Combined Heat and Power (CHP) unit will be correctly sized and installed to provide the base hot water load for the hotel. It is predicted that the CHP, ASHP and energy efficiency measures will reduce CO_2 emissions by 27.0% against the TER.

In line with the *'Be Green'* section of the London Plan, feasibility studies were carried out on the various renewable technologies available for a project of this type. However, due to the Grade II listed status of the building, central London location and LZC technologies proposed, the successful and efficient incorporation of renewable energy has proved difficult without detrimental effects elsewhere. As the requirements of The London Plan 2011 can be met through other measures, no renewables are proposed for the conversion of 203 High Holborn.

2.0 INTRODUCTION

2.1 Background

Applied Energy were appointed by Ediston Opportunity Fund to prepare an Energy and Sustainability Strategy to accompany the planning submission for the proposed conversion of 203 High Holborn in London into a hotel. This statement identifies how the proposed works address the energy related policies of the London Borough of Camden and the Greater London Authority (GLA) as set out in The London Plan 2011.

Options have been reviewed for reducing CO_2 emissions through energy efficiency measures, heating and cooling hierarchy technologies and renewable energy technologies. The local environment and proposed site have been considered throughout.

2.2 Site Description

203 High Holborn is an existing six storey office building situated in close proximity to Holborn underground station. The conversion involves the creation of 138 new bedrooms over seven floors (including basement) with reception, kitchen and ancillary bar and restaurant facilities together with the associated back of house areas.

The site location is highlighted in Figure 1 below:

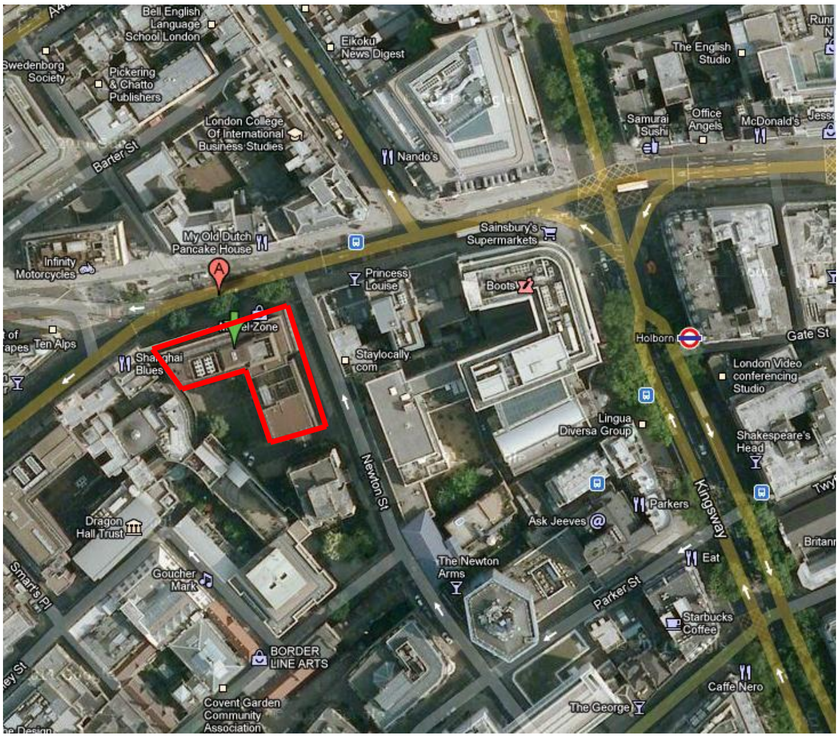


Figure 1: Site Location

2.3 Design Philosophy

This statement has been produced to show the measures economically feasible and practically viable to increase sustainability for the proposed hotel. In line with the London Plan 2011 and the Supplementary Planning Guidance (SPG) "Sustainable Design and Construction" document the use of energy efficiency measures and renewable energy has been investigated to try and achieve the target carbon emissions reduction of 25% on the 2010 Building Regulations Target Emissions Rate (TER).

The mechanical and electrical design will be carefully considered to provide the most efficient balance between requirement, effectiveness, cost and maintainability.

In achieving a sustainable design, it is important that the building is as efficient as possible such that the total base load is minimal. This also helps in reducing the renewable energy requirement. This report highlights the measures that will be taken to improve energy efficiency and assess the viability of the renewable technologies available. All assessments within this report have been made using preliminary information and can be subject to development as the project progresses into the detailed design stage.

2.4 Policy and Planning Context

This energy statement is based on The London Plan 2011 with guidance taken from The Supplementary Planning Guidance (SPG), Renewable Energy Toolkit and Camden Council's Planning Guidance 3 (CPG 3) – Sustainability and includes:

1. An energy demand assessment for heating, cooling and electricity and baseline CO_2 emissions
2. Review the design of the building and the potential for energy efficiency design measures
3. An assessment of the feasibility of low carbon heating and cooling technologies
4. An assessment of renewable energy technologies including details on possible technology/plant sizes and resulting carbon savings
5. A summary identifying the preferred energy strategy and the overall CO_2 emissions reductions achieved over the Building Regulations 2010 compliance baseline

A summary of the relevant policy and guidance documents on which this report is based are listed below:

- Planning for a Sustainable Future – White Paper
- The London Plan: Spatial Development Strategy for Greater London, Consolidated with Alterations since 2004
- London Plan Supplementary Planning Guidance on Sustainable Design and Construction
- The Mayor's Energy Strategy: Green Light to Clean Power, Mayor of London
- Camden Planning Guidance 3 – Sustainability
- Camden Core Strategy and Development Policies

2.5 London Plan 2011

The new London Plan 2011 was released on the 22nd July. This is the first major revision to the London Plan 2008. The London Plan contains an energy hierarchy: **be lean, be clean, be green.** This energy hierarchy outlines the approach to sustainable building design:

- Reduce the energy consumption of a building through passive measures (be lean)
- Supplying energy efficiently via building plant (be clean)

- Make use of renewable energy technologies to supplement conventional fuels (be green)

It is now mandatory under the London Plan 2011 to achieve a 25% improvement in site wide CO_2 emissions via any combination of passive measures, active energy efficiency measures and renewable energy technologies.

This has replaced the requirement for 20% CO_2 reduction via renewable energy technologies previously in place under The London Plan 2008.

2.6 Supplementary Planning Guidance – Sustainable Design and Construction

The SPG published in May 2006 provides additional information to support the implementation of the London Plan. This document cannot set new policies, but has weight as a formal supplement to the London Plan and is applicable to all building types and associated spaces.

The SPG provides guidance on the way that the seven measures identified in the policy can be implemented to meet the London Plan objectives and therefore the SPG is structured around these seven factors.

It should be noted that there are discrepancies between the SPG and London Plan relating to CO_2 target reductions from renewable energy. This report has been produced using the most recent publication which is the London Plan 2011, requiring a 25% improvement in site wide CO_2 emissions.

2.7 Camden Core Strategy and Development Policies

The Camden Core Strategy sets out the overall approach to managing Camden's growth, helping to achieve a Sustainable Camden that adapts to a growing population.

The Camden Development Policies Section 3 contributes to delivering the Core Strategy by providing detailed policies that are used when determining applications for planning to ensure that developments contribute towards making Camden sustainable. Section 3 supports the Core Strategy by focussing on:

- Promoting sustainable design and construction
- Reducing water consumption and the risk of surface water flooding
- Managing the impact of development and noise and vibration
- Air quality and Camden's Clear Zone

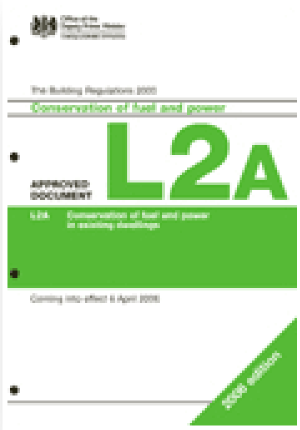
2.8 London Renewables Toolkit

The London Renewables Toolkit helps support planners, developers, consultants and other interested parties in implementing Mayoral and related borough planning policies in London which require renewable energy.

It has been designed to encourage the use of renewable energy technologies in London through new developments and aims to contribute in meeting London's carbon dioxide and renewable energy targets.

2.9 Building Regulations 2010

The Government has used Building Regulations Part L, to bring about the efficient use of energy within new and existing buildings. The regulations are split into 4 sections L1(A/B), L2(A/B) with section L1 covering new and existing dwellings and L2 applicable to all new and existing non-domestic buildings, such as offices, hotels and warehouses. Part L aims to limit the maximum energy usage from mechanical and electrical plant and strives for better quality of construction to reduce building air leakage.



The Government set out in its 'Building a Greener Future' Policy Statement (July 2007) that non-dwellings are to be net zero carbon by 2019. It is likely that following a 25% step change in 2010 similar changes will follow in 2013 and 2016. As a result, changes are being made to Building Regulations Part L to help reduce CO_2 emissions by improving energy efficiency.

3.0 BREEAM ASSESSMENT

In line with the current Camden Planning Guidance 3 (CPG 3) document the proposed development will aim to achieve a minimum BREEAM rating of 'Very Good' with aspirations for 'Excellent'.

The development will also aim to achieve the following as required by Camden Council:-

- Achieve 60% of the credits available under the Water section of the BREEAM assessment
- Achieve 60% of the credits available under the Energy section of the BREEAM assessment
- Achieve 40% of the credits available under the Materials section of the BREEAM assessment

4.0 SIMPLIFIED BUILDING ENERGY MODELLING (SBEM)

4.1 Building Simulation

The proposed hotel has been thermally modelled using EDSL TAS dynamic simulation modelling software. This model has been produced to determine the annual energy demand and resultant CO_2 emissions for the different stages of the proposed scheme.

This software contains the construction database which defines all the construction U-values for the various building elements. Outputs from the simulation program include hourly kW demands for heating, cooling, domestic hot water and small power. The model was simulated using the CIBSE test reference year (TRY) weather data for London, as required by Part L2B of the Building Regulations 2010. The outputs from the software allow gas and electrical consumption and related CO_2 emissions to be calculated and therefore the target reduction in CO_2 emissions to be established.

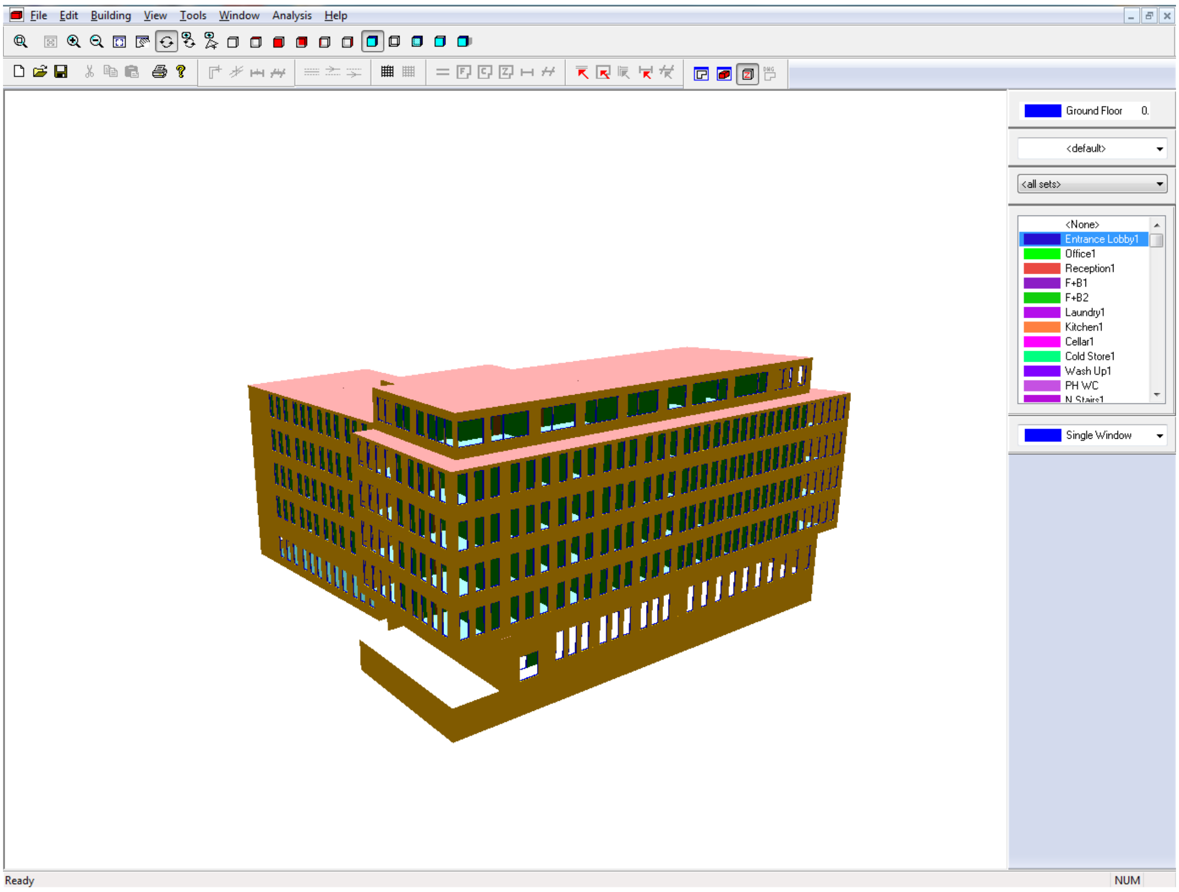


Figure 2: SBEM Model

5.0 ENERGY EFFICIENCY – 'BE LEAN'

The aim of the 'Be Lean' strategy is to reduce energy usage through the inclusion of energy efficiency measures, good practice sustainable building services solutions and improving the performance of those minimum levels stipulated within Part L 2010 of the Building Regulations documents.

The following sections show the proposed measures to be taken to improve energy efficiency.

5.1 Building Fabric Performance

In order to overcome acoustic issues at the site and satisfy the hoteliers in-room noise requirements, substantial enhancement works are proposed to the external and internal walls, floors and windows to improve the acoustic performance. As a result, thermal performance of the building envelope will be improved, minimising unwanted heat loss and/or gain.

The proposed measures will result in U-values for the building fabric that exceed the minimum standards required within Building Regulations Part L2B 2010 and therefore meet current legislation.

5.2 Hot Water

Hot water for the hotel will be generated from high efficiency direct gas fired water heaters with efficiencies of over 90%.

The proposed hot water systems will be selected with low NOx emissions to reduce the impact on the local environment.

5.3 Heating and Cooling – Air Source Heat Pumps

The existing office is fitted with a wet heating system and heated via gas fired boilers which are believed to be in the region of 10 years old. One boiler appears to be out of service. Given the overall condition of the existing boilers it is estimated that their efficiency is approximately 80%.

Cooling is currently provided to the building via electric chillers within the basement plant room with air cooled condensers located on the roof of the main building. The coefficient of performance (COP) of the existing chillers is in the region of 3.5.

An additional air cooled chiller is located on the existing fourth floor roof plant enclosure, however this enclosure and all plant will be removed to allow the construction of an additional floor of bedrooms.

It is proposed that space heating and cooling will be provided to the hotel via high efficiency air source heat pumps to reduce energy usage and to minimise pipework distribution requirements through the use of fewer and smaller pipework.

In the same way as ground source, these do rely on fossil fuels (indirectly) to provide the energy source, whilst the medium (air rather than ground) is not being used as a heat store, air source heat pumps are considered to be a low or zero carbon technology.

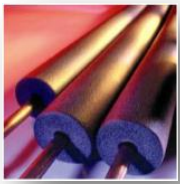
Air source heat pumps extract thermal energy from the surrounding air and can be used to provide heating and/or cooling. It is proposed that the heating and cooling for the bedrooms will be supplied by multiple air source heat pumps and will incorporate heat recovery on the indoor distribution to reduce the amount of operation required by the outdoor unit.

The heat recovery works when different areas on a system require heating and cooling at the same time by transferring the energy between these rooms, e.g. heat is taken from the room that requires cooling and is transferred to the room that requires heating, and vice versa.

Using data from modelling software calculations and Mitsubishi electrical technical information to show improvement in performance, the incorporation and the use of heat recovery can improve the seasonal efficiency by an additional 6% for both the heating and cooling. This in turn gives an equivalent energy saving of 5.5kWh/m^2/year.

The air source heat pumps require electricity to operate but have a high coefficient of performance which is why they are now classed as a low/zero carbon technology. Because Air source heat pumps indirectly require fossil fuels to as a power source, they have not been included within the renewable section of this report but are being utilised in the 'Be Lean' strategy for the building.

5.4 Services Distribution

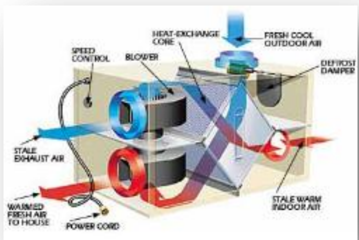


All services pipe work will be insulated to minimise any unwanted heat loss or heat gain.

5.5 Ventilation

The office is currently mechanically ventilated.

The hoteliers brand standard for ventilation is that all bedrooms are provided with in room mechanical supply and extract ventilation heat recovery units ducted directly to outside. This arrangement is unlikely to be achieved at this site due to the existing façade and listed status of the building. Therefore it is therefore proposed that a centralised ducted system will be installed to provide mechanical supply and extract ventilation. The central plant will incorporate a cross flow heat exchanger to provide heat recovery with an efficiency of 70%.



It is proposed that the restaurant and bar areas will be provided with full mechanical ventilation which will incorporate a cross flow heat exchanger to provide heat recovery between the supply and extract ventilation paths.

Ventilation rates and specific fans powers will be in accordance with Building Regulations Part L2B 2010 and CIBSE Guide B2.

Ventilation will also be provided for the catering kitchen. Extract plant is to be located at roof level and will be provided with the necessary levels of odour control in accordance with DEFRA guidelines to minimise air pollution to the neighbouring buildings.

Sound attenuation will be provided to meet the requirements of the acoustic consultant and the local planning authority to reduce the impact of plant noise to the surrounding areas.

5.6 Lighting

The current lighting within the office consists mainly of fluorescent and low voltage dichroic fittings. To improve efficiency and reduce the connected lighting load within the building, it is proposed that high efficiency lamps with high frequency ballast and automatic and/or manual switching facilities will be provided. The use of photocells (daylight sensors) to control the external lighting will be investigated. Consideration will be given to the use of PIR detectors to control lighting in low occupancy back of house areas and bedroom corridors.

The lighting design throughout the hotel will incorporate high efficacy lamps to ensure compliance with Building Regulations whilst providing the required lighting levels and environment. The use of LED lighting, where appropriate, will be installed within bedrooms and public areas.

A typical bedroom within the hoteliers portfolio uses less than 100W of lighting.

5.7 Water Consumption

With the proposed change of use of the building from an office to a hotel, it is likely that the water consumption of the site will increase due to the servicing and operational nature of a hotel. In order to minimise the impact of the redevelopment on the local water infrastructure, water saving techniques will be incorporated to help reduce site consumption.

Below is a list of proposed water saving measures:

Water Storage

The Institute of Plumbing recommend that water storage for budget hotels is 150 litres per bedroom. The design for the proposed hotel has been based on providing 125 litres per bedroom. This accounts for a 17% reduction in water usage.

Dual Flush Toilets

The Climate Change and The Demand for Water Report 1996 state that the use of water for flushing toilets uses on average 30% of the domestic water demand.

Dual flush cisterns allow users to decide whether to flush only a portion of, or all the water from the cistern.

It is proposed that dual flush cisterns (4 litres/6 litres) are installed to help contribute to improved water savings.

Low Flow Bathroom Taps

Low flow bathroom taps will be provided in all guestrooms in line with the hoteliers brand standards to minimise water usage. The taps will be specified to provide a flow rate of 6 litres per minute.

Low Flow Showers

Low flow shower heads will be provided in all guestrooms in line with the hoteliers brand standards to minimise water usage. The showers will be specified to provide a flow rate of 9 litres per minute.

Urinal Flush Controls

In order to save water in the public toilets the installation of urinal flush controllers are proposed. Passive Infrared (PIR) detectors will be fitted to individual urinals so they only flush when movement is detected rather than using a timed flushing system.

Sensing and Percussion Taps

Sensor taps use PIR sensing to detect the presence of an object which then sends a signal to the solenoid valve to initiate the flow of water. When the object is no longer present, the infrared unit sends an electronic signal back to the solenoid valve to terminate the flow of water thereby saving any potential water wastage.

Percussion taps or self-closing taps as they are otherwise known, have a slow release valve mechanism which, once pressed, allows the flow of water for a predetermined time before the valves closes. By having this level of control, it eliminates human error and the possibility of taps being left on for long periods of time.

It is proposed that percussion or sensing taps are provided to all the public and staff toilets to help minimise water wastage.

5.8 Summary

A summary of the above proposed measures and energy efficient figures to be used in the modelling of the development are detailed in Table 2.

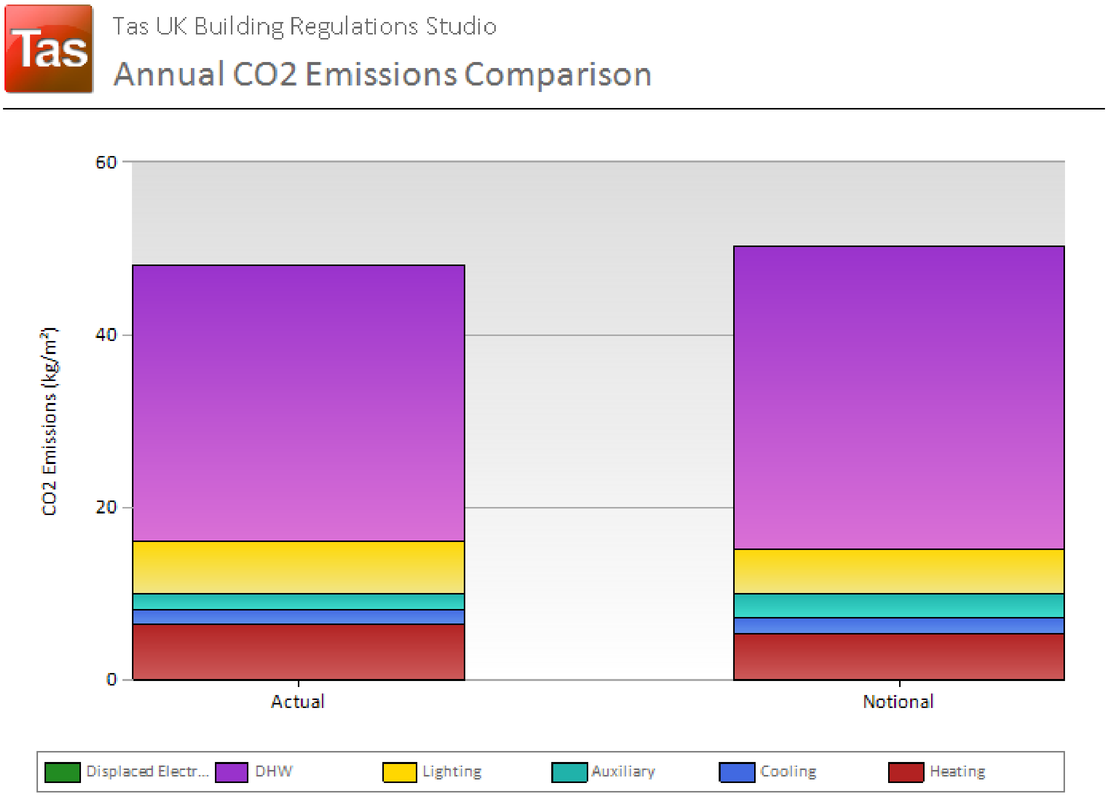
HVAC Plant	Baseline (2010 L2B Minimum Values)	'Be Lean' (Proposed Building Values)
Boiler Efficiency	86%	92%
Heating Delivery Efficiency	N/A	100%
Heat Recovery Efficiency	50%	70%
ASHP (Heat Generator Efficiency)	2.2 (220%)	4.14 (414%)
Cooling System Seasonal Energy Efficiency Ratio (EER)	2.5	4.14
Cooling Delivery Efficiency	N/A	100%
Domestic Hot Water Efficiency	73%	92%
AHU with Heat Recovery Specific Fan Power (W/l/s)	1.8	1.5
Local Fan Specific Fan Power (W/l/s)	0.6	0.5
U-Values (W/m^2K)		

Wall	0.30	0.2
Floor	0.25	0.2
Roof	0.25	0.2
Windows	2.0	1.5
Personnel Doors	N/A	2.08
High Usage Entrance Doors	N/A	1.86

Table 2: 'Be Lean' Design Criteria

5.9 Calculations

TAS simulates the building for an entire year, calculating the total energy demands for heating, cooling, hot water, lighting and fan power based on specific input data for the hotel, such as plant efficiencies, room uses and building fabric. From these figures, the resulting CO_2 emissions are obtained and compared against the notional model as detailed below.



Graph 2: CO_2 Emissions From 'Be Lean' Measures

The Building Emissions Rate (BER) for the proposed hotel achieved a 4.2% reduction in CO_2 against the 2010 Target Emissions Rate (TER) from the inclusion of energy savings measures* alone.

Model	Gross Internal	TER	BER	Percentage

	Floor Area (m^2)	($kgCO_2/m^2/$ annum)	($kgCO_2/m^2/$ annum)	Reduction over TER
203 High Holborn	5,341	50.3	48.2	4.2%

Table 3: 'Be Lean' SBEM Results

*The energy reduction calculated by TAS in Table 4 is based on the high coefficient of performance (COP) of the ASHP outdoor units. The calculations within TAS do not account for the heat recovery facility of the AC system, which reduces requirement to operate the outdoor units. The additional energy reduction as a result of the heat recovery is detailed in Table 4.

Model	Gross Internal Floor Area (m^2)	TER ($kgCO_2/m^2/$ annum)	Heat Recovery CO_2 Reduction ($kgCO_2/m^2/$ annum)	BER ($kgCO_2/m^2/$ annum)	Percentage Reduction over TER
203 High Holborn	5,341	50.3	3.0	45.2	10.1%

Table 4: ASHP Heat Recovery Calculations

6.0 ENERGY HIERARCHY – 'BE CLEAN'

6.1 Be Clean Strategy

For conversion projects such as 203 High Holborn, Policy 4A.6 of the London Plan sets out a preferred technology hierarchy in respect of supplying the energy demands for heating, and where necessary, cooling. This is as follows:

- Connection to existing CCHP/CHP distribution networks
- Site-wide CCHP/CHP powered by renewable energy
- Gas-fired CCHP/CHP or hydrogen fuel cells, both accompanied by renewables
- Communal heating and cooling fuelled by renewable sources of energy
- Gas fired communal heating and cooling

6.2 Connection to Existing CCHP/CHP Distribution Networks

The London Heat Map tool has been used to determine if there any existing district heating or cooling schemes available to connect to within the area. The map in Figure 3 indicates that there is no existing district heating 'network lines' or 'network nodes' within the area. Also it is shown that the site location (Corner of High Holborn and Newton Street) falls outside of the district heating opportunities focus area.

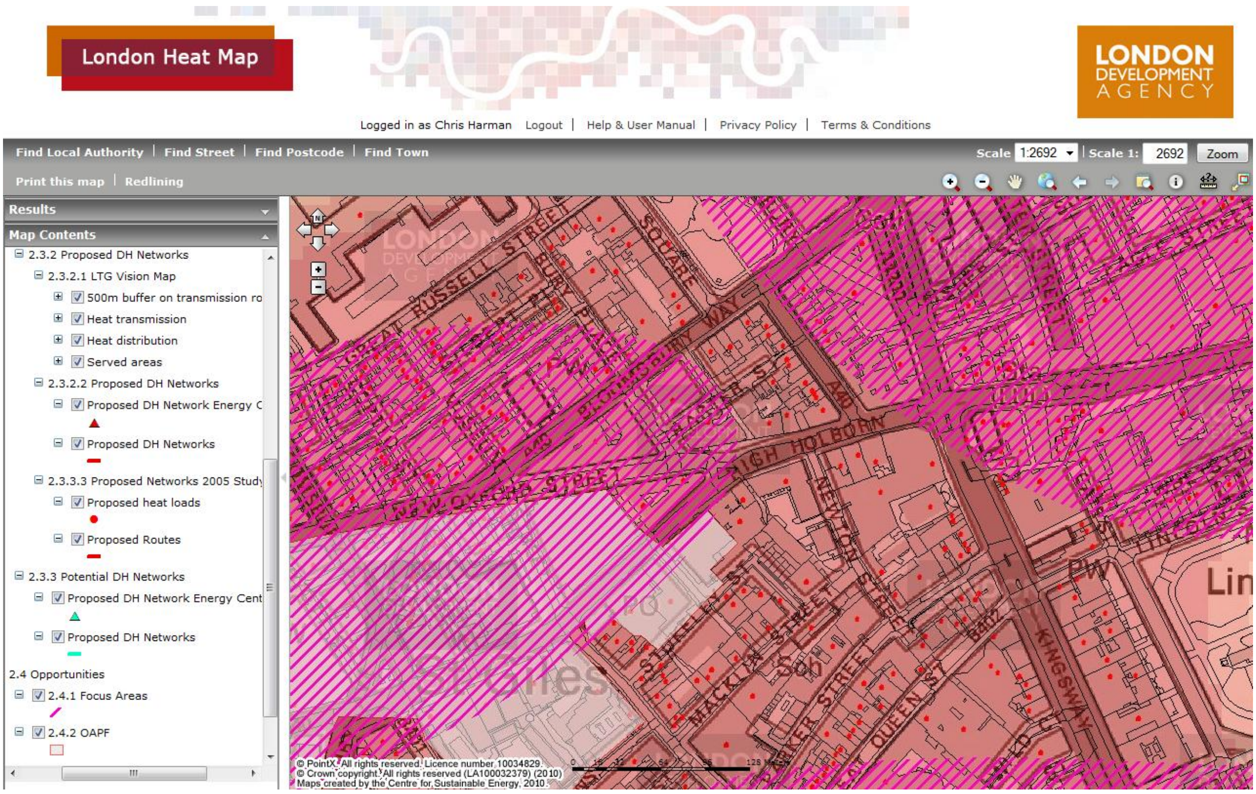


Figure 3: London Heat Map – High Holborn (and Newton Street), London

From the map, there appears to be no communal or district heating scheme in close proximity to the site at this time. In case a suitable district heating scheme becomes available in the future it is proposed that the design of the building services systems will be such that connections will be achievable for any distribution network as and when they become available in the future.

6.3 Site-wide CCHP/CHP Powered by Renewable Energy

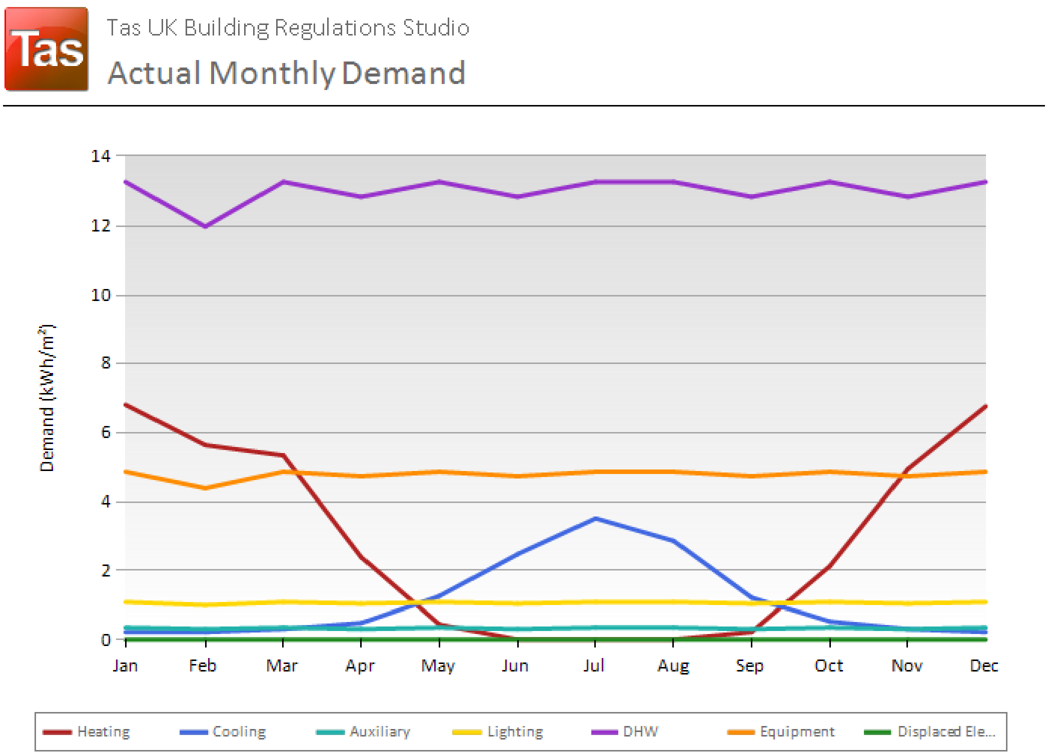
Biomass CCHP/CHP is still in the demonstration phase and is therefore not considered suitable for commercial operation. Bio-diesel has unresolved issues as a fuel for CHP. At present it is not known how much energy is used to produce the fuel therefore the true effect on site of the CO_2 emissions is uncertain. Digester gas involves using the methane produced from anaerobic decomposition of bio-degradable waste as a fuel for the CHP. The bio-digesting plant requires a large amount of space which is not available on this project. It is therefore concluded that CCHP/CHP powered by renewables is not suitable for this project given the building size and location.

6.4 Hydrogen Fuel Cells Accompanied by Renewables

Hydrogen fuel cells are relatively new technology and would be fed from a natural gas supply due to the lack of a hydrogen network at present. The capital cost of such a system is much greater than that of a gas-fired CHP of similar size. The technology still very embryonic, therefore the use of fuel cells are not recommended for this site.

6.5 Gas-fired CCHP/CHP Accompanied by Renewables

Gas fired CHP is a well proven technology in hotels when sized correctly and utilised to its full potential. The domestic hot water load represents the largest year round heat load in a hotel environment as shown in graph 3, and is therefore well suited to the use of CHP. The installation of a CHP to provide the base hot water load is therefore proposed.



Graph 3: SBEM Heating, Cooling and Hot Water Monthly Demands

The modelling shows a monthly hot water demand of approximately 13kWh/m^2 which when applied the floor area of the building (5,341m^2) equates to 69,433kWh per month or 2,314kWh per day.

Experience shows that in a hotel environment, hot water consumption has two peak periods a day; one early morning and one early evening. There is a small base hot water load provided throughout the remainder of the day from kitchen and bar areas and housekeeping. CHP units operate most efficiently with a constant base load, minimising modulation which can reduce the unit's effectiveness. Therefore providing a standard instantaneous hot water generation system would not suit the provision of a CHP. However, this can be overcome by using efficient engineering solutions and effective water storage techniques to ensure that the CHP runs for the majority of the day. In this instance, the hotel could benefit from the installation of a CHP unit to provide the base hot water needs.

Discussions have been made with CHP manufacturers and suppliers in order to obtain a proposal and determine the most suitable CHP size that would provide the level of service required whilst maximising efficiency.

From these proposals, it is recommended that a 20kWe CHP is installed to provide the hotels base hot water load producing:-

- 20kWe of electricity which will provide the anticipated base daily consumption
- 48kWth of thermal energy used to provide the base hot water load

If the CHP unit is set to run 12 hours a day, this would provide approximately 672kWh of heat a day which equates to approximately 25% of the anticipated daily hot water load. Gas fired high efficiency water heaters will be provided to offer top up/ backup services when the CHP is unable to provide the required load.

From these proposals, it is proposed that a micro CHP is installed to provide the hotels base hot water load and generate electricity to offset that taken from the grid.

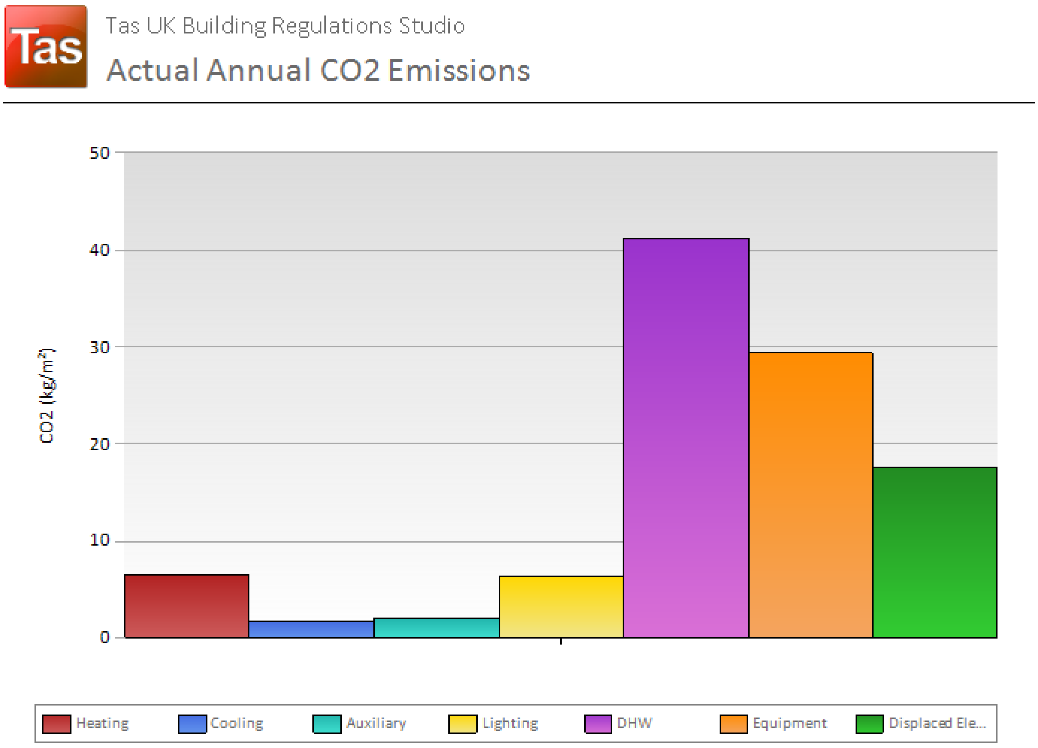
6.6 Calculations

The building has been modelled again with the inclusion of a gas fired CHP providing the hotels base hot water load.

The following assumptions have been used in the modelling of the CHP which are based on manufactures data and Building Regulations Part L2B 2010 minimum requirements:

- Quality Index (Q1) – 120
- CHP efficiency – 85%
- Heat to Power Ratio – 2.4

The resulting annual CO_2 emissions from the inclusion of the CHP are shown in graph 4:



	Heating	Cooling	Auxiliary	Lighting	DHW	Equipment	Displaced Electricity
$CO2\ (kg/m^2)$	6.37	1.65	1.95	6.23	41.11	29.43	17.60

Graph 4: Annual CO_2 Emissions from 'Be Clean' Measures

The BER for the development now achieves a further 16.9% reduction in CO_2 against the 'Be Lean' strategy BER which included the energy savings measures only. This combines to give an overall reduction of 27.0% against the 2010 TER.

Model	Gross Internal Floor Area (m^2)	TER ($kgCO_2/m^2$/ annum)	BER ($kgCO_2/m^2$/ annum)	AC Heat Recovery CO_2 Reduction ($kgCO_2/m^2$/ annum)	Revised BER ($kgCO_2/m^2$/ annum)	Percentage Reduction over TER
203 High Holborn	5,341	50.3	39.7	3.0	36.7	27.0%

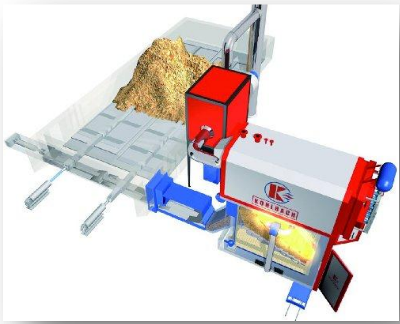
Table 5: 'Be Clean' SBEM Results

7.0 RENEWABLE MEASURES – 'BE GREEN'

This section reviews the potential on-site renewable energy technologies available and assesses their viability in conjunction with the CHP.

- Biomass Boilers
- Ground Source Heat Pumps (GSHP)
- Solar Thermal
- Solar Photovoltaic (PV)
- Wind Turbines

7.1 Biomass Boilers



The spatial requirement for biomass plant, equipment and associated fuel storage is significant. Given the buildings central London location and on-going fuel delivery requirement the inclusion of biomass has not been deemed appropriate.

Biomass requires frequent and regular deliveries of fuel which would impact on local transportation due to site servicing constraints and would therefore not be suitable for this redevelopment.

There are many discussions at this time with regards to the suitability of biomass within the GLA region due to the Clean Air Act requirements and the viability of clean biomass systems has not yet been proven.

Investigations were made to combining the use of CHP and biomass with the former reducing CO_2 emissions and the latter providing a renewable contribution. The modelling showed direct conflicts between the two technologies resulting in loss of efficiency of both systems.

It is therefore believed that this technology is not suitable for commercial operation in combination with the proposed CHP set.

7.2 Ground Source Heat Pumps

Ground source can be used to provide heating and or cooling to the building. Whilst ground source does rely on fossil fuels (indirectly) to provide the energy source, they are considered renewable given their high coefficient of performance and hence reduced fossil fuel reliance.

This can be one of four methods:

- Closed horizontal loops in the strata, generally comprising a number of flow and return horizontal coiled loops often referred to as "slinkies".

- Closed vertical loops in the strata, generally comprising a number of flow and return vertical loops to approximately 100m.
- Open loop, generally comprising of an abstraction and rejection well
- Abstraction only open loop, comprising of an abstraction well with water rejected to either the local sewer systems or river/water course.

In order to provide the anticipated heating and cooling loads for a hotel of this size, a large amount of bore holes would be required with sufficient distance needed between them. With this site being an existing building and having no private external areas, ground source heat pumps are not deemed suitable for this project and have not been considered further.

7.3 Solar Thermal

It is proposed that the hotel will use a CHP set to provide the base hot water requirements for the hotel. CHP units operate most efficiently with a constant base load, minimising modulation which can reduce the unit's effectiveness. By introducing solar thermal technology to pre-heat the domestic hot water, the base load is reduced thereby affecting the performance of the CHP.

It is deemed that incorporating CHP with solar thermal will not provide an efficient and effective system and therefore has not been considered for this application.

7.4 Wind Turbine

This section covers both large scale and micro wind solutions.

Large scale wind generation systems have capacities over 100kW and are usually used to power larger developments such as, larger scale housing, industrial estates and hotels with many rooms. These systems cannot be roof mounted due to their size and weight.

Due to the large capital cost, building location and surroundings, large scale wind turbine systems are not considered viable at this project.

It is difficult to obtain predictable or large amounts of wind energy in city centre locations, as they require non-turbulent, horizontal air streams to be most effective. Surrounding buildings, trees etc. can cause significant issues with regards to micro and large scale installations unless the rotors are positioned at a considerable height. An indicative layout is shown in Figure 4.

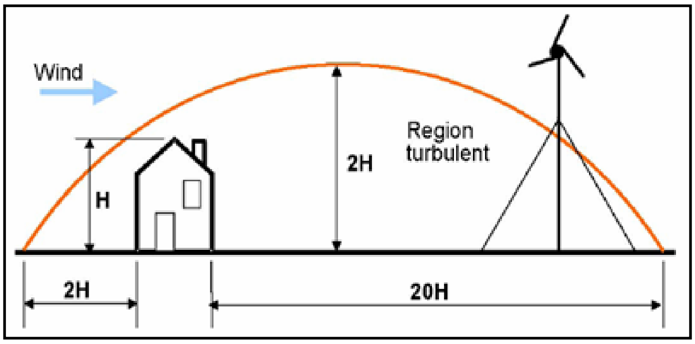


Figure 4: Large Scale Wind Turbine Layout

Micro wind turbine technology has been found to be extremely difficult to achieve a 20% contribution economically. A significant number of units would be required to provide any reasonable energy savings which would have serious visual impact implications.

Tall buildings give their own specific problems in that the building act as a spoiler, pushing wind upwards and over the turbine, reducing effectiveness considerably.

Additional considerations with large and micro wind solutions are the potential issues from stroboscopic light, topple distance, noise, impact on wildlife and structural enhancements which all raise major concerns given the building central London location.

Given the building location in central London and its close proximity to nearby buildings, achieving an acceptable solution that will provide sufficient renewable contribution as well as overcome the installation impacts is unlikely and therefore has not been considered for this project.

7.5 Solar PV

Using data from the National Energy Foundation it is evident that Solar Photovoltaic installations give an extremely poor return on investment.

As the proposed energy efficiency measures and LZC technologies satisfy the requirements set out in The London Plan 2011, the incorporation of solar PV has not been considered further.

9.0 SUMMARY, CONCLUSIONS & RECOMMENDATIONS

Table 6 summarises the CO_2 emissions for the development for each stage of the assessment:

- 'Be Lean' (Energy Efficiency)
- 'Be Clean' (CHP)
- 'Be Green' (Renewable Technology)

The proposed energy efficiency measures and LZC technologies meet the London Plan 2011 requirement for 25% improvement on the Part L 2010 Building Regulations Target Emissions Rate.

203 High Holborn	CO_2 Emissions (kg CO_2/yr/m^2)	% Improvement CO_2 Emissions Over TER
Target Emissions Rate (TER)	50.3	-
'Be Lean' – Energy Efficiency	45.2	4.2%
'Be Clean' – Gas Fired CHP	36.7	27.0%
'Be Green' - Renewables	-	-

Table 6: CO_2 Emissions Scheme Comparison

Many conclusions and recommendations have been made in the previous sections of this report. In this section the main conclusions and recommendations are summarised.

The investigation of CO_2 emissions savings involved the analysis and simulation of:

- Energy Efficiency Measures
- Hierarchy of Heating and Cooling Technologies
- Renewable Energy Technologies

It is proposed that the following energy efficiency measures are provided to reduce energy demand for the building before low or zero carbon technologies have been considered:

- Energy efficient lighting
- Incorporation of high efficiency air source heat pumps
- Heat recovery provided to air handling plant
- Improved services distribution

The most appropriate heating technology for the hotel is considered to be a gas fired CHP. It is proposed that this is incorporated into the building to provide a proportion of DHW.

Due consideration has been given to the different renewable technologies available, however due to the central London location, listed status of the building and proposed LZC technologies, the opportunities are limited. It has been deemed unpractical to provide any further renewable capacity without severe detrimental effects elsewhere.

With the energy efficiency measures proposed; ASHP (including AC heat recovery) and gas fired CHP, a total reduction of 27.0% on the 2010 TER CO_2 emissions is achievable.