PARSONS BRINCKERHOFF

August 2015

# RAMSAY HALL

## *University College London*

### *Energy and Sustainability Statement*

3512445D-BBG

# University College London
# Ramsay Hall

## Energy and Sustainability Statement

**3512445D-BBG**

**Prepared for**
University College London

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# 1 EXECUTIVE SUMMARY

WSP | Parsons Brinkerhoff was commissioned by University College London (UCL) to complete the energy and sustainability strategy for the proposed refurbishment and extension of Ramsay Hall. This provides a number of opportunities to reduce the building energy demand and improve sustainability.

Ramsay Hall consists of four blocks; Rome, Paris, London and New York. There is also a block in the courtyard, Ian Baker House, which falls outside of the scope of this project, but is connected to the central building services. The proposed includes a small extension at ground floor level and an extension of one additional floor on the Rome Block.

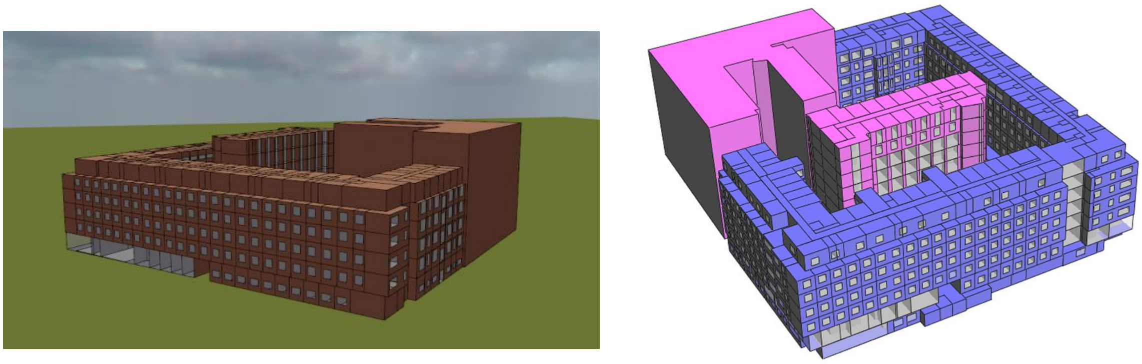

**Figure 1: Ramsey hall IES model**

## 1.1 Energy and Carbon Targets

Multiple layers of energy and carbon requirements apply to the development at a national, regional and local level, each of which requires different targets to be met. The development will be designed to target the most onerous requirements applicable at each phase of development.

On that basis, the implications of the relevant targets for the proposed development can be summarised as follows:

- All development must meet the prevailing Building Regulations requirements. The development will be brought forward under Part L 2013 and this has been used as the basis of this energy statement.
- Camden's planning requires that refurbishment should make "every effort to improve energy performance", although an overall carbon reduction target is not set.

## 1.2 Energy Strategy

The energy statement has been structured in accordance with the energy hierarchy: Be Lean, Be Clean, Be Green.

The proposals for the scheme have been developed in accordance with the desire to achieve an energy efficient and sustainable development.

The building will be designed to achieve optimum energy performance and will incorporate the following design features:

- All the single glazed windows to be replaced with double glazing
- All spaces will include 100% low energy lighting
- Include highly efficient heating boiler
- Use low fan power ventilation
- Incorporate CHP system
  Allow for future connection to a District Energy Network for heating (potentially fed from Euston Road decentralised energy network.
- Include a Solar PV system

## 1.3 Energy Results

Accredited Design Dynamic thermal simulation software was used to determine the regulated and non-regulated carbon emissions.

The completed models include baseline carbon emissions, carbon emissions after the application of energy efficiency measures and the carbon emissions after the application of low and zero carbon technologies. The results are shown in Table 1 below.

**Table 1 Carbon emissions reductions**

| | REGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | UNREGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | % REDUCTION IN REGULATED CARBON EMISSIONS |
|---|---|---|---|
| Part L 2013 Compliant design (based on Target Emission Rate – TER) | 599.83 | 186.98 | -45.81% |
| After 'lean' energy demand reduction | 742.89 | 186.98 | -23.85% |
| After 'clean' energy demand reduction | 568.46 | 186.98 | +5.16% |
| After 'green' energy demand reduction | 562.2 | 186.98 | +6.25% |

### 1.4 Sustainability objectives

The overarching project objectives are to ensure that the accommodation and administrative spaces created are comfortable and functional for domestic and international clients.

Improving the energy efficiency of the building is another key driver in this project. In order to deliver this, the design proposal focuses on providing an optimum environment for the end users. A significant component of this is to ensure sustainability is central to the development. In particular, achievement of BREEAM 2008 'Very Good' as a base is required. UCL however have an aspiration to achieve an 'Excellent' rating.

UCL's objectives for sustainability have been outlined in the *UCL Sustainable Design Specification for Ramsay Hall*. This document presented the design team with key sustainability targets, including:

- BREEAM 2008 'Very Good' as a base is required, but an achievement of 'Excellent' is desired.
- Achieve a 25% improvement on the $CO_2$ target emissions rating excluding any benefit for CHP, as calculated under 2013 Building Regulations Part L.
- Natural and passive design options for thermal control, ventilation and lighting are to be favoured over active mechanical/electrical systems.
- Achieve a reduction in in-use water demand aligned to HEEPI best practice of less than $9m^3$ per person per year.
- All main building elements to be BRE Green Guide A/A+ rated.
- All new appliances to be A+ rating.
- Responsible, sustainable and local sourcing of materials is to be prioritised.
- Reference to policy DP22.

## 2 PROJECT BACKGROUND

### 2.1 Development description

The entire building will consist of fully refurbished facilities, including, new en-suite bedrooms; kitchens, offices; administration; and opportunities to improve the common areas and storage facilities currently available. In all of these alterations and additions, sustainability is a major feature of the proposed design.

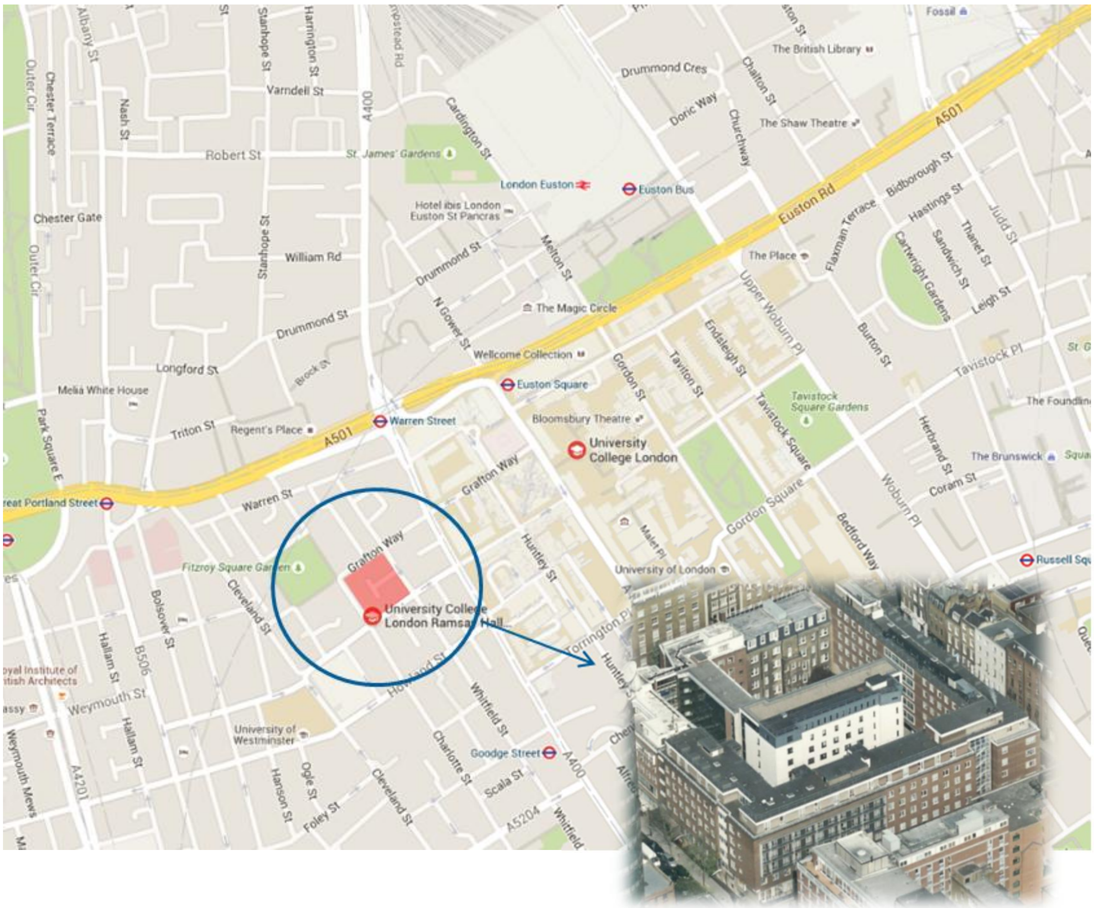


Figure 2: Current building location

## 3 POLICY CONTEXT

Camden's approach to sustainable development is underpinned by policies from the London Plan, the Camden Core Strategy 2010-2025 – Local Development Framework and Camden Planning Guidance – Sustainability (CPG3)

### 3.1 The London Plan

The Mayor of London published the London Plan in July 2011. Key policies underpinning London's approach to sustainable development include:

- Policy 5.2 – Minimising Carbon Dioxide Emissions
- Policy 5.3 – Sustainable Design and Construction
- Policy 5.5 – Decentralised Energy Networks
- Policy 5.6 - Decentralised Energy in Development Proposals
- Policy 5.7 – Renewable Energy
- Policy 5.9 – Overheating and cooling

The Mayor's London Plan sets out policy in the London context and identifies a number of objectives to improve the City as a place to work and live. Policy 5.2 sets out the requirements to minimise $CO_2$ emissions through the application of the energy hierarchy:

1. **Be lean**: use less energy
2. **Be clean:** supply energy efficiently
3. **Be green:** use renewable energy


**Figure 3: London Borough of Camden Energy Hierarchy**

London Plan policy requires new buildings to achieve a 40% carbon emissions reduction over Part L (2010) of the Building Regulations between 2013 and 2016.

From 5th July 2014 this target was rebased against Part L 2013, to require new development to achieve a 35% against the Part L 2013. This is considered to be equivalent to a 40% reduction over Part L 2010.

The London Plan requires an assessment of energy demand that demonstrates the steps taken to apply the Mayor's energy hierarchy. The London Plan includes planning policies both for reducing energy consumption within buildings and the use of renewable energy. These policies cover the role of the boroughs in supporting the Mayor's energy strategy and the requirements of planning applications.

For projects where an existing building or group of buildings is refurbished it is still expected that developers provide an energy assessment demonstrating how the individual elements of the energy hierarchy have been implemented within the project and reductions in regulated $CO_2$ emissions have been achieved.

Where significant refurbishments are being carried out, it is expected that an estimate of the $CO_2$ savings from the refurbishment of the building is provided. To provide this, firstly the regulated $CO_2$ emissions of the unrefurbished, existing building should be modelled using building regulations compliance software to determine a BER/DER, which will be used to determine a baseline. The BER/DER of the refurbished building should also be determined at each stage of the energy hierachy using building regulations compliance software. These figures should then be used to report the $CO_2$ savings at each element of the energy hierarchy.

It is appreciated that the nature and level of carbon savings that can be achieved from refurbishments can vary considerably, however every effort should be made to improve the energy performance of the building and follow the energy hierarchies in Policy 5.2 and 5.6 of the London Plan.

### 3.2 Camden Core Strategy and Development Policies

The Camden Core Strategy was adopted in November 2010 sets out the key elements of the borough's vision and is central to the Local Development Framework (LDF). The Core Strategy is the key spatial planning document for Camden, setting out the vision for the Borough over the next 15 years and how it will be achieved.

The Camden Core Strategy requires all developments to provide a 20% reduction in carbon dioxide emissions through on-site renewable energy generation where feasible.

Core Strategy CS13 – *Tackling climate change through promoting higher environmental standards* promotes higher environmental standards through:

- Ensuring developments use less energy.
- Making use of energy from efficient sources and decentralised energy networks.
- Generate renewable energy on-site.
- Promoting the development of new decentralised energy facilities that have the potential to link into a wider sub-regional network, in particular in the vicinity of housing estates with community heating or the potential for community heating, schools, or other suitable locations.

Development Policy DP22 – Promoting sustainable design and construction works in conjunction with the strategy in policy CS13 by providing detail of the sustainability standards expected in developments:

- Demonstrate how sustainable development principles have been incorporated into the design and proposed implementation.
- Incorporate green or brown roofs and green walls wherever suitable.
- Expect non-domestic developments of 500m² of floor space or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.
- Developments must be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:
    - ➢ Summer shading and planting
    - ➢ Limiting run-off
    - ➢ Reducing water consumption
    - ➢ Reducing air pollution
    - ➢ Not locating vulnerable uses in basements in flood-prone areas

### 3.3 Camden Planning Guidance – Sustainability CPG3

The Camden Planning Guidance CPG3 supports the policies in the Local Development Framework (LDF). This guidance is therefore consistent with the Core Strategy and the Development Policies, and forms a Supplementary Planning Document (SPD) which is an additional "material consideration" in planning decisions.

- Developments of 500m² (gross internal) floor space or more are required to submit an energy statement which demonstrates how carbon dioxide emissions will be reduced in line with the energy hierarchy.
- As a guide, at least 10% of the project cost should be spent on environmental improvements.
- All developments are to be designed to minimise carbon dioxide emissions by being as energy efficient as is feasible and viable.
- Where feasible and viable the development will be required to connect to a decentralised energy network or include CHP.

## 4 BASELINE CARBON EMISSIONS

To show the potential improvements to the Ramsay Hall to limit carbon emissions, a 'baseline' model has been constructed in the IES-ve software using a Dynamic Thermal Model (IES-ve version 2014 - 5.2b.1).

The initial baseline model has been constructed to be representative of the existing building. The method of compliance is to demonstrate that the carbon emissions from the design, or Building Emissions Rate (BER), are no greater than a Target Emissions Rate (TER). The TER is determined from a 'Notional' building which is of the same size, shape and usage as the actual design, but has standardised fabric and system efficiencies. It should be noted that as the baseline design follows the existing building, the baseline model is not expected to pass the criterion 1 carbon emissions check in the first instance.

A summary of the baseline building's fabric and services efficiency is below in Table 2.

Table 3 summarises the baseline carbon emissions for the whole development in the baseline model.

**Table 2: Breakdown of model parameters for baseline building**

| MODEL PROPERTY | UNIT | VALUE IN BASELINE BUILDING |
|---|---|---|
| **Building Fabric** | | |
| External wall U-value | W/m²K | 1.68 |
| Roof U-value | W/m²K | 1.42 |
| Floor U-value | W/m²K | 0.45 |
| Window U-value | W/m²K | 5.6 |
| Window g-value | - | 0.64 |
| Air permeability | m³/hr.m² @50Pa | 7 |
| **LTHW Heating-Nat Vent** | | |
| Heating efficiency | % | 89 |
| Cooling efficiency (seasonal EER) | - | - |
| Specific Fan Power | W/l/s | 0 |
| Heat recovery | % | - |
| **Fan Coil Units** | | |
| Heating efficiency | % | 4.52 |
| Cooling efficiency (seasonal EER) | - | 3.28 |
| Specific Fan Power | W/l/s | 1.6 |
| Heat recovery | % | 65 |
| **DX System** | | |
| Heating efficiency | % | 5.2 |
| Cooling efficiency (seasonal EER) | - | 4.07 |
| Specific Fan Power | W/l/s | 0 |
| Heat recovery | % | - |
| **Ancillary Systems** | | |
| DHW efficiency | % | 89 |
| DHW Storage | litres | 1000 |
| DHW Standing Losses | kWh/litre.day | - |
| General lighting efficiency | Lm/W | 80 |
| Lighting control | - | none |
| **Target Emission Rate (TER)** | $kgCO_2/m^2$ | 47.8 |
| **Building Emission Rate (BER)** | $kgCO_2/m^2$ | 69.7 |
| **Percentage Pass** | % | -45.81% |

**Table 3: Overall baseline regulated and unregulated carbon emissions for baseline building and Part L 2013 compliant design**

| | REGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | UNREGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) |
|---|---|---|
| Baseline Building (BER) | 874.66 | 186.98 |
| Part L 2013 Compliant design (based on Target Emission Rate – TER) | 599.84 | 186.98 |

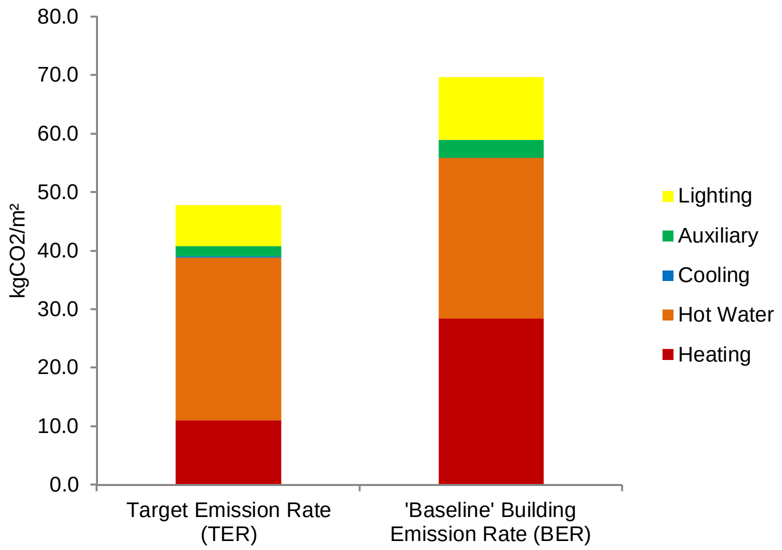


**Figure 4: Plot of regulated $CO_2$ emissions for Baseline and Compliant (TER) design**

The current energy efficiency of the building is low due to the materials used in construction and due to the age of the building as well as the lighting. Two models were run, the first with the building as it stands with the second model containing the improvements to the building mentioned in the next section.

The building currently has total $CO_2$ emissions of 69.7 kg/m$^2$, which represents 874.66tonnes of $CO_2$ per annum.

## 5 BE LEAN: REDUCE ENERGY DEMAND

Following the completion of the baseline model, the 'lean' improvements aim to reduce energy demand by further improving the fabric and systems within the building. The objective of this model is to achieve compliance with the Building Regulations Part L 2013 without the use of CHP or renewable technologies.

The general assumptions applied are outlined below and the following table provides the detail used in the Part L model.

### 5.1 Improvements to building fabric

The efficiency of the fabric assumed in the baseline model is not compliant with the minimum requirements of the Building Regulations Part L. The lean model has improved these values, which will have a direct bearing on space heating/cooling load.

- Highly insulating facade elements have been proposed in-line with the notional building definition of the forthcoming Building Regulations Part L 2013.

- The glazing in the existing building is currently single glazed with an approximate U-value of 5.75 W/m$^2$K. This glazing will be replaced with new double glazing with a U-value of 1.6 W/ m$^2$K or better and will also be selected with a lower 'g-value' to limit solar heat gain and subsequent retrofitting of inefficient comfort cooling.
- The building fabric of the extension has been selected to limit the energy demands of internal spaces as far as possible.
- Air leakage from new facade elements will be an improvement on the requirements of the Part L criteria for new buildings.

### 5.2 Efficient ventilation systems

Spaces with no access to natural ventilation through the facade are to be provided with full heat recovery ventilation. Heat recovery ventilation is also to be provided to these spaces for use in the winter months. In the summer, mechanical ventilation shall be reverted to cooling and purge ventilation. This strategy is more energy saving than year round natural ventilation which may suffer from uncontrolled 'trickle' heat losses. Similar demand based control is also proposed for energy efficiency.

A fully natural ventilation strategy is proposed for the bedrooms with single sided ventilation. Trickle ventilation shall be installed as standard on the windows to ensure minimum ventilation during winter and limiting excessive heat loss and draughts.

In addition, hours of operation of active ventilation systems shall be reduced through demand based controls, sensing occupancy, internal $CO_2$ build up and high temperatures where appropriate.

Passive and natural systems are prioritised to reduce building loads. This includes extensive use of natural ventilation where possible. The majority of the spaces are naturally ventilated apart from a few specific areas on ground and lower ground floors.

In the kitchens and toilets, where extract ventilation cannot be ventilated locally, common ventilation is proposed. This will utilise presence detection to reduce air flow rate, and low electrical fan power, whenever possible. The ventilation units shall be located on the roof, adjacent to the existing ventilation plant.

### 5.3 Heating system improvements

The current boiler will be replaced with a new condensing type, with an efficiency of 97.3%.

In addition, each bedroom will be provided with new radiators with thermostatic radiator valves.

## 5.4 Efficient lighting

The high carbon intensity of electricity and long operational hours of the building means significant savings will be achieved through lighting:

- Where possible, daylight will be utilised to reduce the demand for electrical lighting.
- Use of absence detection to switch off lights when a space is vacated.
- Energy requirements for artificial lighting shall be reduced through efficient LED fittings (circa 20% more efficient that the existing system).
- In addition, demand based controls, absence detection or natural daylight at the perimeter shall be used to reduce hours of operation.

**Table 4: Fabric, Building Services and Lighting values provided in Lean model**

| MODEL PROPERTY | UNIT | VALUE IN BASELINE BUILDING | VALUE IN 'LEAN' BUILDING |
|---|---|---|---|
| **Building Fabric** | | | |
| External wall U-value | W/m²K | 1.68 | 1.68 |
| Roof U-value | W/m²K | 1.42 | 1.42 |
| Floor U-value | W/m²K | 0.45 | 0.45 |
| Window U-value | W/m²K | 5.6 | 1.6 |
| Window g-value | - | 0.64 | 0.4 |
| Air permeability | m³/hr.m² @50Pa | 7 | 5 |
| **LTHW Heating-Nat Vent** | | | |
| Heating efficiency | % | 89 | 97.3 |
| Cooling efficiency (seasonal EER) | - | - | - |
| Specific Fan Power | W/l/s | 0 | 0 |
| Heat recovery | % | - | - |
| **Fan Coil Units** | | | |
| Heating efficiency | % | 4.52 | 4.52 |
| Cooling efficiency (seasonal EER) | - | 3.28 | 5.8 |
| Specific Fan Power | W/l/s | 1.6 | 1.6 |
| Heat recovery | % | 65 | 65 |
| **DX System** | | | |
| Heating efficiency | % | 5.2 | 5.2 |
| Cooling efficiency (seasonal EER) | - | 4.07 | 4.8455 |
| Specific Fan Power | W/l/s | 0 | 0 |
| Heat recovery | % | - | - |
| **Ancillary Systems** | | | |
| DHW efficiency | % | 89 | 97.3 |
| DHW Storage | litres | 1000 | 1000 |
| HW Standing Losses | kWh/litre.day | - | - |
| General lighting efficiency | Lm/W | | 65 |
| Lighting control | - | none | Photo-sensors |
| Target Emission Rate (TER) | $kgCO_2/m^2$ | 47.8 | 47.8 |
| Building Emission Rate (BER) | $kgCO_2/m^2$ | 69.7 | 59.2 |
| Percentage Pass | % | -45.82% | -23.85% |

## 5.5 Carbon Emission Reduction

Based upon the energy efficiency measures outlined, and excluding the contribution of CHP, District Energy Networks or other renewable energy systems the following total carbon emissions are calculated (see Table 5).

The carbon emissions for the development are shown to be higher than the minimum requirements of the Building Regulations by 23.85%.

**Table 5: Be Lean: Carbon emissions after the application of energy efficiency measures**

| | REGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | UNREGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | % REDUCTION IN REGULATED CARBON EMISSIONS |
|---|---|---|---|
| Baseline Building (BER) | 874.66 | 186.98 | - |
| Part L 2013 Compliant design (based on Target Emission Rate – TER) | 599.84 | 186.98 | -45.81% |
| After 'lean' energy demand reduction | 742.89 | 186.98 | -23.85% |

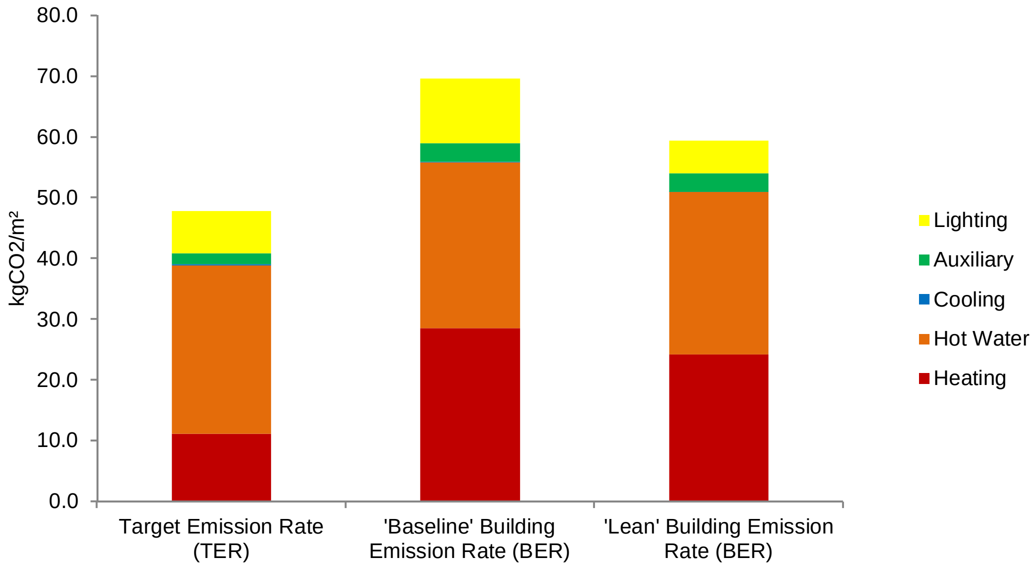


**Figure 5: Plot of regulated $CO_2$ emissions for Baseline, Compliant (TER) and Lean design**

## 6 BE CLEAN: SUPPLY ENERGY EFFICIENTLY

After consumption has been reduced through the application of energy efficiency measures, the next step is to consider low carbon technologies in order to provide further reduction in carbon dioxide emissions.

The following low carbon technologies have been investigated for the Proposed Development.

- Install a Combined Heat and Power (CHP) system with a new suitable sized CHP, as this is past its life expectancy. This will be connected to a central heating and domestic hot water system to supply heating and domestic hot water to all four blocks.
- District heating network (DEN).

**Borough of Camden Guidance (CPG3):**

5.16 As a guide, developments and areas with the following characteristics will be suitable for decentralised and CHP systems:

- High heating demand;
- Mixed energy demands – a range of electricity and heating demands throughout the day; and
- Located close to an existing or emerging decentralised energy network.

5.17 Developments which fall within proposed within 1km of an existing decentralised energy network, or one that is likely to be operational within 3 years of occupation of the development, should assess the feasibility of connecting to the network...
…A connection should be made unless it can be clearly demonstrated that it would not be viable. Where no connection is made, a financial contribution will be sought.

5.18 Developments which are proposed within 500m of a potential network which have no timetable for delivery should ensure that the development is capable of connecting to a network in the future. A financial contribution will be sought to fund the future expansion of the network, unless on-site CHP is feasible and included as part of the development.

Figures 6 and 7 show the 1km and 500m radius from current DEN networks as provided in CPG3. Clearly the proposed site of the Ramsay Hall falls within both of these zones making the viability of connection worthy of further investigation.

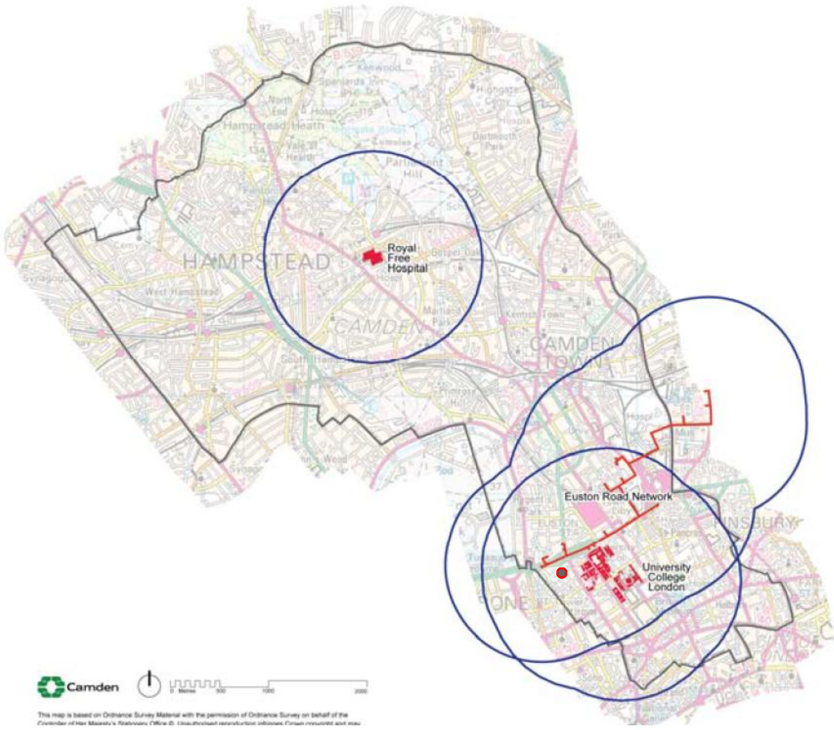


**Figure 6: Developments within 1km radius of an existing or emerging network (CPG3)**

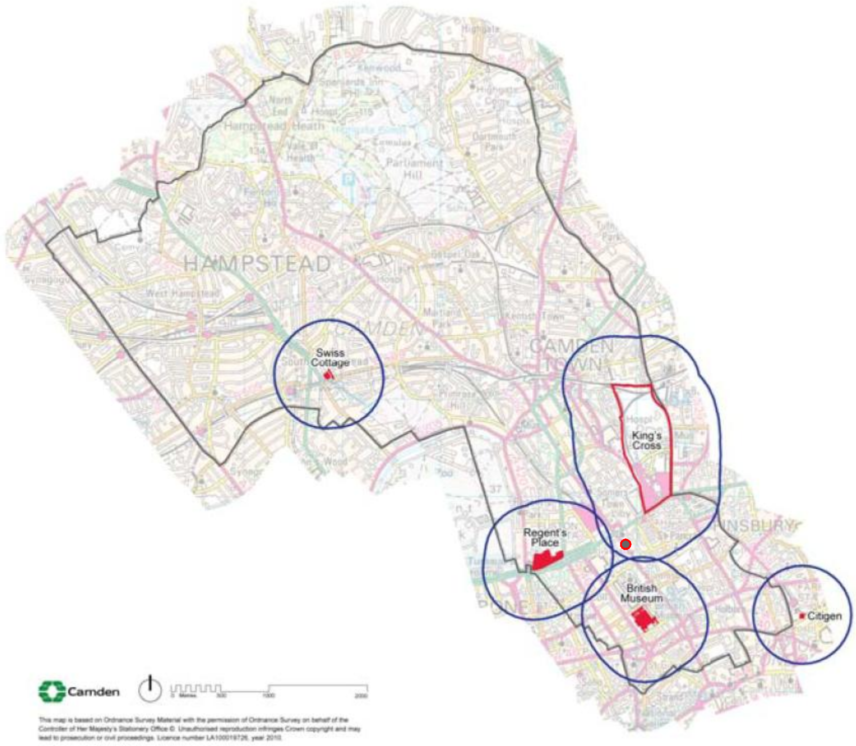


**Figure 7: Developments within 500m radius of a potential network (CPG3)**

Figure 8 is a more recent map of known schemes and potential future developments in Camden. This was provided by Camden in the recent 'Decentralising Camden' event of 21st May 2015.

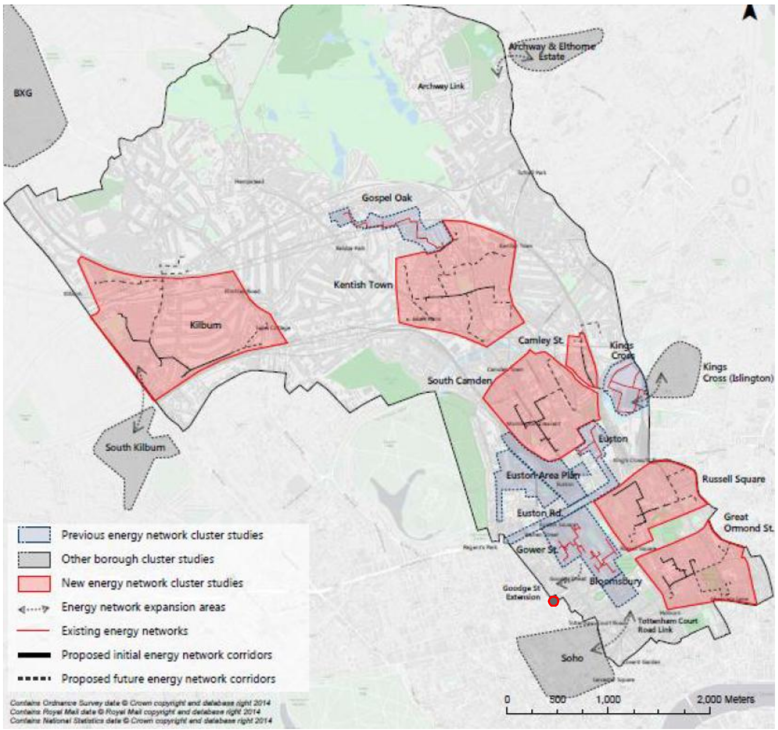


Figure 8: Current Cluster Areas (Decentralising Camden event of 21st May 2015)

In total, two potential schemes have been investigated:

- Connection to the existing Bloomsbury & Gower street Heat and Power network
- Connection to the proposed Euston road DEN

## 6.1 Bloomsbury & Gower street Heat and Power Network

Operated by University College London (UCL), this scheme (the Gower Street Heat & Power Decentralised Energy network) serves the main UCL Bloomsbury Campus as well as a number of University College London Hospital (UCLH) buildings.

According to discussions with Harold Garner and Celeste Giusti of the LB Camden there are plans for major expansion and incorporation of other UCL and UCH buildings.

The consortium is looking at the potential for expanding the scheme to supply other heat and power loads in the area.

Parsons Brinckerhoff has recently completed a study for the BHP consortium that looks at the technical feasibility of extending the network. The study identified a potential district heating network expansion route along Endsleigh Street to connect Conaught Hall and other student residences in this area.

The following map shows that Ramsay Hall is located in an energy network expansion area.

Ramsay Hall site is less than 300m from the proposed network expansion. It is suggested that discussions are initiated with the BHP energy manager in order to determine the potential for including Ramsay Hall in the expansion of this network.


**Figure 9: Current Cluster Areas (Decentralising Camden event of 21st May 2015)**

## 6.2 Euston Road decentralised energy network

The London heat map has been produced by the GLA in order to assist developers and local authorities with identifying areas that have the potential to form a decentralised energy network. The following figure has been taken from the London heat map. The red lines indicates potential future heat networks whilst the purple shading represents areas considered to have the potential for decentralised energy network development.


**Figure 10: Extract form London Heat Map showing Euston Road DEN to North (www.londonheatmap.org.uk)**

Ramsay Hall is located approximately 250m from the proposed Euston Road decentralised energy network. At present this network is understood to be in the concept stage, however if the building does not have its own CHP or connect to the BHP network, then connection to this network should be investigated as and when the network is constructed.

Measures required to future proof the design for future connection to a DEN will include space allowance for a plate heat exchanger and associated pipe and valve arrangements.

### 6.3 Potential Clean savings due to District Network connection

To consider the potential $CO_2$ savings from connection to a district energy network, Euston Road energy network has been selected as the most viable. This is primarily due to its proximity to the site, as shown in Figure 10 and the relatively recent nature of the data available.

For the Euston Road energy network, the following CHP values are suggested:

*CHP Electrical Efficiency = 30%*
*CHP Thermal Efficiency = 48%*

This gives an overall CHP efficiency of 78% and a heat to power ratio of 1.6.

It is assumed that the CHP unit would be installed in an Energy Centre arrangement that gave 60% of annual load from the CHP and 40% from gas fired boilers with a seasonal efficiency of 92%.

Based on these values, provision of 1kWh of heat from the system would result in 0.17kg$CO_2$. With estimated distribution losses of 5%, a final carbon intensity for the DEN system of 0.177kg$CO_2$/kWh has been assumed.

With this value applied to the model, the following results have been generated. The final viability of the system towards 'Clean' savings will be considered after the suitability of local CHP as an alternative option. This is summarised in the next section.

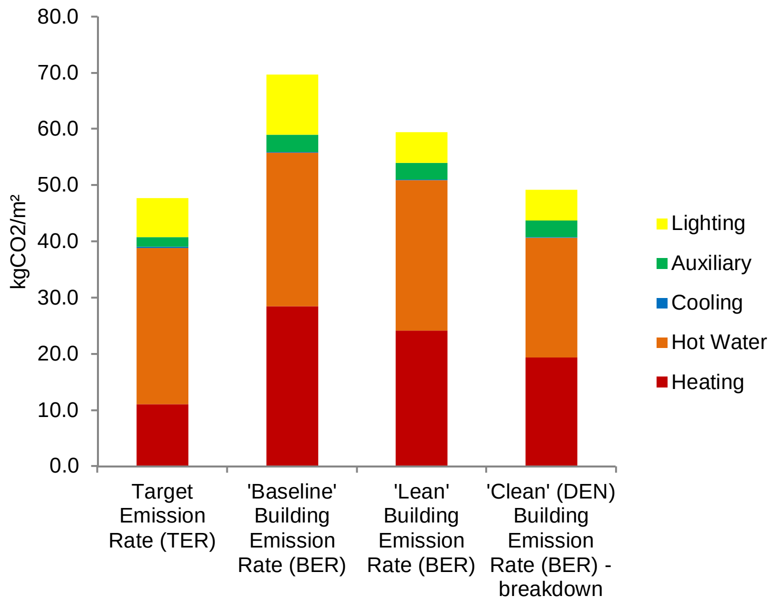


**Figure 11: $CO_2$ reduction from Clean (DEN) measures**

**Table 6- Be Clean: Carbon emissions after the application of connection to a local District Energy Network (DEN)**

| | | BASELINE | LEAN | CLEAN (DEN) |
|---|---|---|---|---|
| Target Emission Rate (TER) | $kgCO_2/m^2$ | 47.6 | 47.6 | 38.3 |
| Building Emission Rate (BER) | $kgCO_2/m^2$ | 69.7 | 59.2 | 49 |
| Percentage Pass | % | -45.82% | -23.85% | -28% |

## 6.4 Combined Heat and Power (CHP)

On the basis of the modest $CO_2$ savings resulting from connection to a future DEN, local CHP has also been considered.

The technical and economic viability of operating a CHP plant in new development is dependent on understanding the building heat and power demand profiles.  A correctly designed CHP unit should be able to supply at least 60% of the annual heating and hot water demand whilst meeting the majority of the on-site electrical demand.

Ramsay Hall is anticipated to have a 24-hour occupancy profile combined with a requirement for a high number of air changes per hour in some areas.  These characteristics indicate that there would be a well-defined heating and electrical base load, therefore on-site CHP could potentially make a significant contribution towards the sites energy demands.  The size of the CHP that could supply the building is dependent on the energy efficiency (lean) measures that can be applied to the building.

To determine the indicative benefits of a CHP system, initial calculations have been completed using the dynamic thermal model for Part L. It is stressed that Part L of the building regulations stipulates use of these calculations are for compliance purposes only. The proper sizing of a CHP system (in the following stages of design development) must be completed using appropriate thermal design software. Calculations at this stage can only be considered indicative of the magnitude of savings.

**To complete the calculations, a CHP engine has been selected to determine the magnitude of potential $CO_2$ savings. The unit is assumed to have a thermal output of 217kW with a thermal efficiency of 50% and a power efficiency of 31%.**

It should be noted that Ramsay Hall currently has a CHP system installed. The calculations are based on a notional CHP system as the remaining life of the unit is unknown.

The plot below illustrates the benefit of a CHP as a 'clean' improvement. Note that the marginally increased heating and hot water emissions are due to the additional gas usage in the CHP engine. The grid displaced electricity (i.e. generated by the CHP) is shown as a negative emission. The aggregated emissions (i.e. accounting for the displaced electricity demand) are shown below.

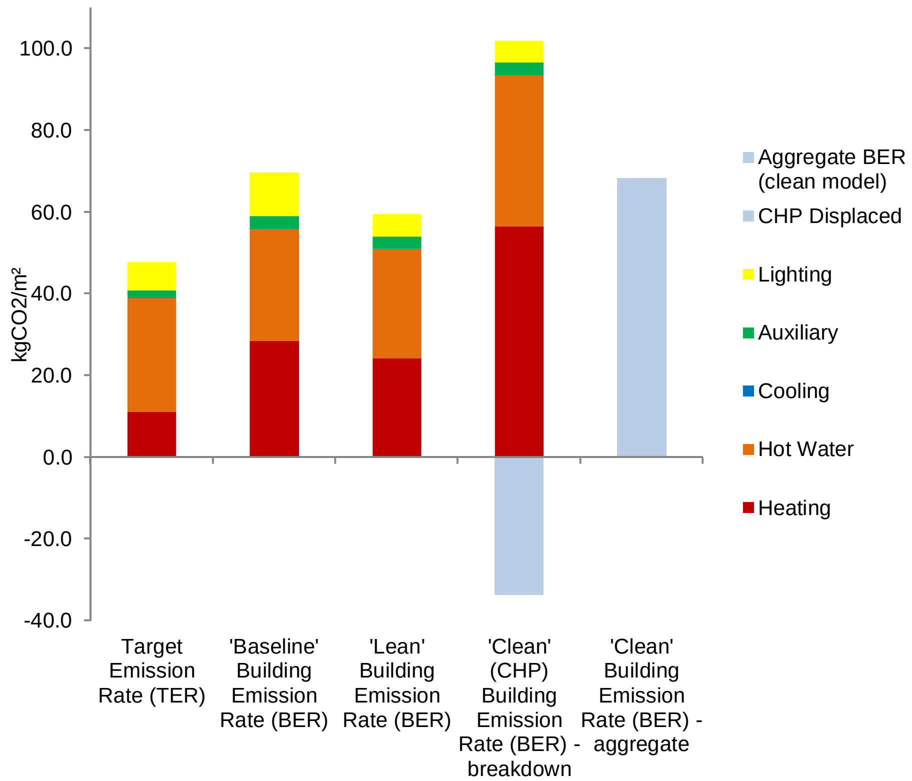


**Figure 12: $CO_2$ reduction from Clean (CHP) measures**

**Table 7- Be Clean: Carbon emissions after the application of connection to a local CHP**

| | | BASELINE | LEAN | CLEAN (CHP) |
|---|---|---|---|---|
| Target Emission Rate (TER) | $kgCO_2/m^2$ | 47.6 | 47.6 | 47.6 |
| Building Emission Rate (BER) | $kgCO_2/m^2$ | 69.7 | 59.2 | 45.3 |
| Percentage Pass | % | -45.82% | -23.85% | +5.16% |

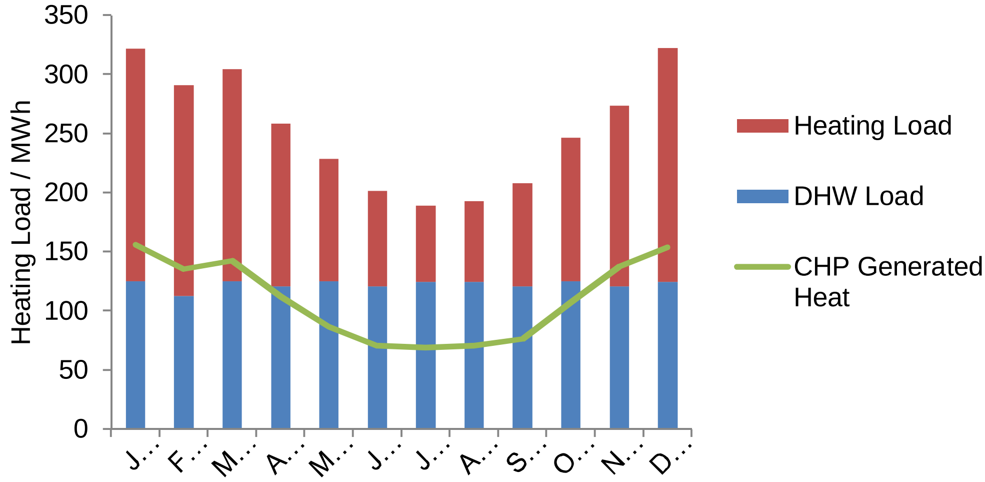


Figure 13: Annual heating showing provision from the CHP led heating system

## 6.5 Carbon Emissions Reduction

With the addition of CHP, carbon reductions are taken to 5.16% above building regulations requirements, which is an improvement of circa 36% from the existing building emissions rate.

Due to the large proportion of energy being used for heating and hot water, the new CHP will be utilised to provide as much of this energy as possible. The annual savings resulting from CHP justify its inclusion in the proposal.

The savings from connection to a future DEN are modest. However, given the current unknowns allowance will be made for future connection.

Table 9- Be Clean: Carbon emissions after the provision of energy efficiency supply measures

| | REGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | UNREGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | % REDUCTION IN REGULATED CARBON EMISSIONS |
|---|---|---|---|
| Baseline Building (BER) | 874.66 | 186.98 | - |
| Part L 2013 Compliant design (based on Target Emission Rate – TER) | 599.84 | 186.98 | -45.81% |
| After 'lean' energy demand reduction | 742.89 | 186.98 | -23.85% |
| After 'clean' energy demand reduction (CHP) | 568.46 | 186.98 | +5.16% |

## 7 BE GREEN: RENEWABLE ENERGY TECHNOLOGIES

After making improvements to Ramsay Hall though 'lean' and 'clean' measures, 'green' or renewable energy measures have been considered.

The drivers for inclusion of renewable technologies also come from the BREEAM assessment in addition to Camden's targets. Criteria Ene01 Reduction of Carbon Emissions offers credit for carbon reduction, although this can arise from any building improvement (not just renewable technology). In addition, further credit is available from Ene05 Low zero carbon technologies for offsetting emissions through renewable technologies directly. In the present BREEAM pre-assessment, a 10% contribution from renewable technologies is targeted.

The London Borough of Camden Planning Guidance document CPG3 includes the following statement concerning renewable energy:

"All developments are to target at least a 20% reduction in carbon dioxide emissions through the installation of on-site renewable energy technologies. Special consideration will be given to heritage buildings and features to ensure that their historic and architectural features are preserved."

The Core Strategy policy CS13 document - *Tackling climate change through promoting higher environmental standards* goes on to state:

"Developments will be expected to achieve a 20% reduction in carbon dioxide emissions from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible".

Given the constraints of the site, opportunities for low and zero-carbon technologies are limited. Initial considerations are as follows:

- **District Energy Networks** may be considered in the future, however current studies indicate no local networks are presently available. Allowance has been made to a future network, although estimates savings are expected to be small.
- **Biomass heating** requires significant space for solid fuel storage. Given space is limited; this is likely to be unfeasible. In addition, initial analysis has suggested thermal energy requirements for the site are relatively low compared to electricity loads. The benefit biomass can offer to total carbon reductions will therefore be limited.
- **Solar hot water** may be feasible, but this technology will reduce base load heating demand, thereby reducing the running hours of potential CHP. Finally, the technology requires roof space that may be utilised for photovoltaic cells, which are generally a more effective (and economic) carbon reduction technology.
- **Building integrated wind systems** are generally ineffective in built-up areas due to turbulence. In addition, other technologies generally show larger carbon savings for a similar level of investment.
- **Solar photovoltaic system**. It is currently proposed that a 100m$^2$ (12.5kWe) Photovoltaic Array be allowed for on the rooftop of the building. The addition of

this system has reduced emissions by a further 6.2 Tonnes of $CO_2$ per annum to. Recent equipment price reductions, coupled with 'feed-in tariffs', have made this technology economically viable in many situations.

The above points are by no means exhaustive, and will be returned to during design development. At the current time, inclusion of a CHP is likely to be feasible, along with potential installation of a Solar PV system.

To demonstrate the effectiveness of PV, 100 m² array (12.5kWp) with a nominal efficiency of 16% (azimuth 140 degrees from North, 30° inclination) is proposed for location on the existing roof. Figure 14 below shows the potential carbon reduction.

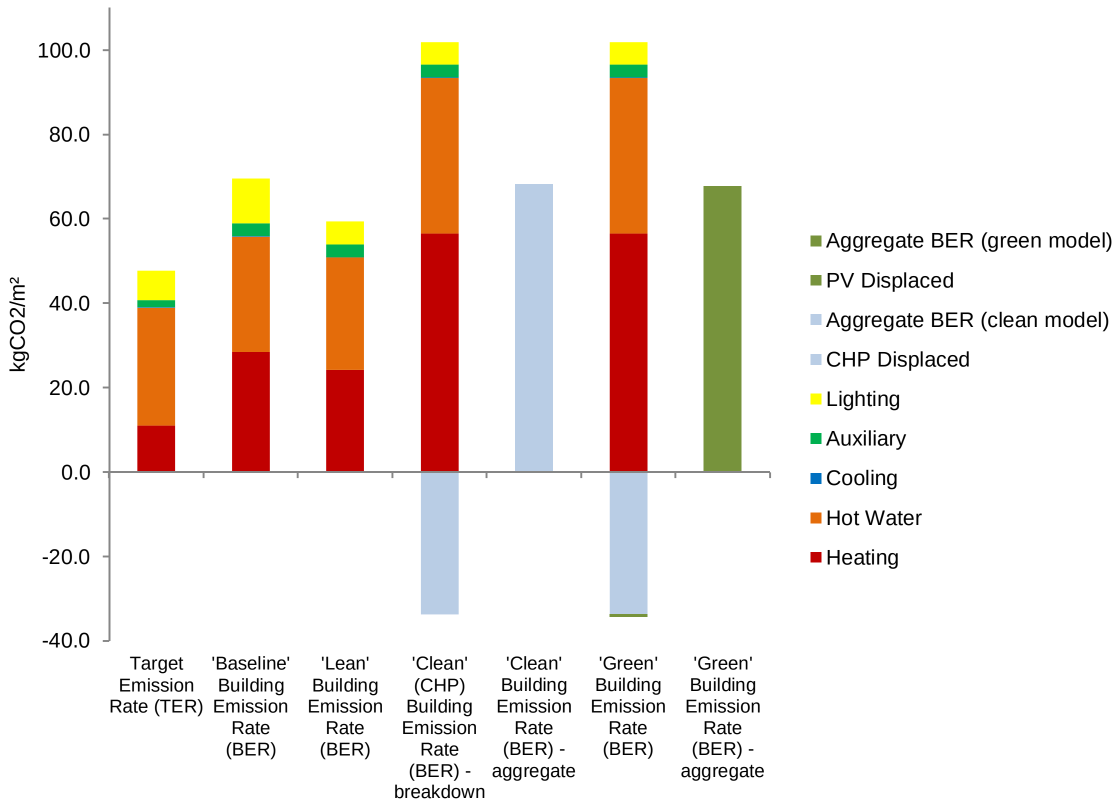


**Figure 14: $CO_2$ Emissions from Target Building, Baseline Model, Lean Model, Clean Model and Green Model**

**Table 10- Be Green: Carbon emissions after the application of connection to a local District Energy Network (CHP)**

| | | BASELINE | LEAN | CLEAN (CHP) | GREEN |
|---|---|---|---|---|---|
| Target Emission Rate (TER) | $kgCO_2/m^2$ | 47.6 | 47.6 | 47.6 | 47.6 |
| Building Emission Rate (BER) | $kgCO_2/m^2$ | 69.7 | 59.2 | 45.3 | 44.8 |
| Percentage Pass | % | -45.82% | -23.85% | +5.16% | +6.25% |

### 7.1 Carbon Emissions Reduction

With the final 'Green' improvements made, the building's $CO_2$ emissions are now circa 5.88% above the Part L 2013 target. Applying all the proposed measures will reduce 389.9 tonnes $CO_2$ per annum, which will represent an improvement of 39.58% from the existing building emissions.

The modest improvement over the Part L target is due to the following reasons:

- This is an existing building and therefore fabric improvements are limited.
- The lighting load is high relative to other loads. An efficient lighting scheme has been selected and any further reductions to lighting load will be challenging.

**Table 11- Be Green: Carbon emissions from all energy saving technologies**

| | REGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | UNREGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | % REDUCTION IN REGULATED CARBON EMISSIONS |
|---|---|---|---|
| Baseline Building (BER) | 874.66 | 186.98 | - |
| Part L 2013 Compliant design (based on Target Emission Rate – TER) | 599.84 | 186.98 | -45.82% |
| After 'lean' energy demand reduction | 742.89 | 186.98 | -23.85% |
| After 'clean' energy demand reduction | 568.46 | 186.98 | +5.16% |
| After 'green' energy demand reduction | 562.2 | 186.98 | +6.25% |

## 8 ENERGY RESULTS

The three principal steps taken; Be Lean (Use Less Energy), Be Clean (Supply Energy Efficiently) and finally Be Green (Renewable Technology measures) are summarised below. The target (Building Regulations compliant) carbon emissions for the Proposed Development are calculated to be 599.84 Tonnes $CO_2$ per annum.

### 8.1 Energy Conservation and energy efficiency (Be Lean)

Through the application of the measures identified in Section 5 the regulated carbon emissions are shown to be 742.89 Tonnes $CO_2$ per annum, achieving an improvement from the existing building emissions of 15% and 132 Tonnes $CO_2$ per annum.

### 8.2 Supply Energy Efficiently (Be Clean)

The application of low carbon technologies has been explored and one solution is now proposed:

A connection to the district heating network is feasible, however on the basis of the modest $CO_2$ savings resulting from connection to a DEN we propose to provide a centralised CHP led LTHW heating system. The CHP system engine(s) and associated storage will be designed to meet at least 60% of the building's annual heating demand.

The regulated carbon emissions for this scenario are 568.46 Tonnes $CO_2$ per annum. The use of CHP provides a reduction in regulated emissions of 35% and 174.43 Tonnes $CO_2$ per annum.

## 8.3 Renewable Technology (Be Green)

The feasibility of a range of renewable technologies has been assessed in the context of the London Plan.

The proposed Photovoltaic Array on the rooftop of the building has reduced emissions by a further 6.2 Tonnes of $CO_2$ per annum to the final value of 562.2 Tonnes, achieving a carbon emission improvement of 35.72%.

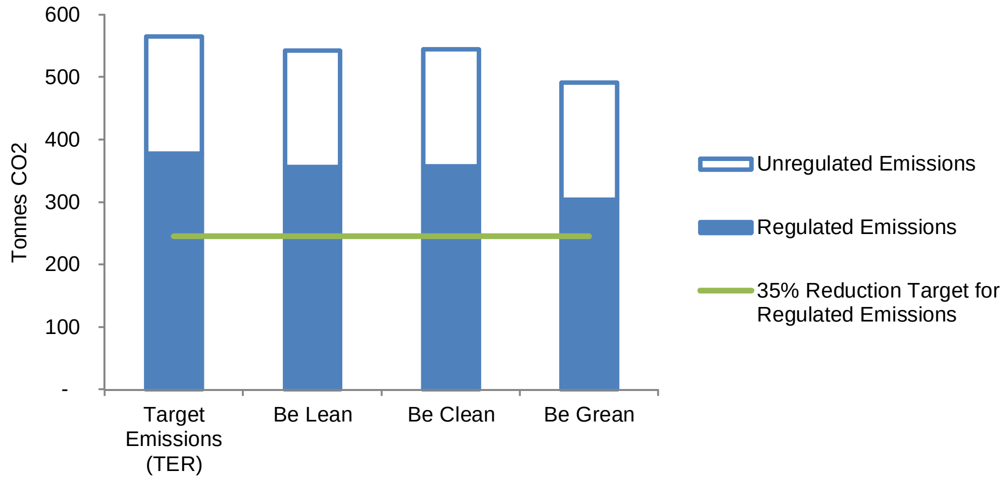


**Figure 15: Total $CO_2$ reductiosn form Lean, Clean and Grean measures**

## 8.4 GLA guidance on preparing energy assessments

In direct response to the information outlined within the 2011 Greater London Authority (GLA) Guidance on preparing Energy Assessments, the results outlined previously are summarised in the tables below, with the results presented against the overall carbon reduction target.

For projects where an existing building or group of buildings is refurbished it is still expected that developers provide an energy assessment demonstrating how the individual elements of the energy hierarchy have been implemented within the project and reductions in regulated $CO_2$ emissions have been achieved.

Where significant refurbishments are being carried out, it is expected that an estimate of the $CO_2$ savings from the refurbishment of the building is provided. To provide this, firstly the regulated $CO_2$ emissions of the unrefurbished, existing building should be modelled using building regulations compliance software to determine a BER/DER, which will be used to determine a baseline. The BER/DER of the refurbished building should also be determined at each stage of the energy hierachy using building regulations compliance software.

It is appreciated that the nature and level of carbon savings that can be achieved from refurbishments can vary considerably, however every effort should be made to improve the energy performance of the building and follow the energy hierarchies in Policy 5.2 and 5.6 of the London Plan.

**Table 12: Carbon Dioxide Emissions after each stage of the Energy Hierarchy**

| | REGULATED EMISSIONS (TONNES $CO_2$ PER ANNUM) | % REDUCTION IN REGULATED CARBON EMISSIONS |
|---|---|---|
| Part L 2013 of the Building Regulations Compliant Development | 599.84 | -31.42% |
| After energy demand reduction | 742.89 | -23.85% |
| After CHP | 568.46 | +5.16% |
| After renewable energy | 562.2 | +6.25% |
| | | |
| **Total Target Savings** | 389.9 | 35% |
| **Annual Surplus** | -172.3 | |

## 9 BREEAM PRE-ASSESSMENT

BREEAM is a whole building assessment method that looks at all aspects of a building's design and the BRE has weighted each element as an indicator of its functional performance relating to energy use within buildings. The respective section weightings are outlined below.

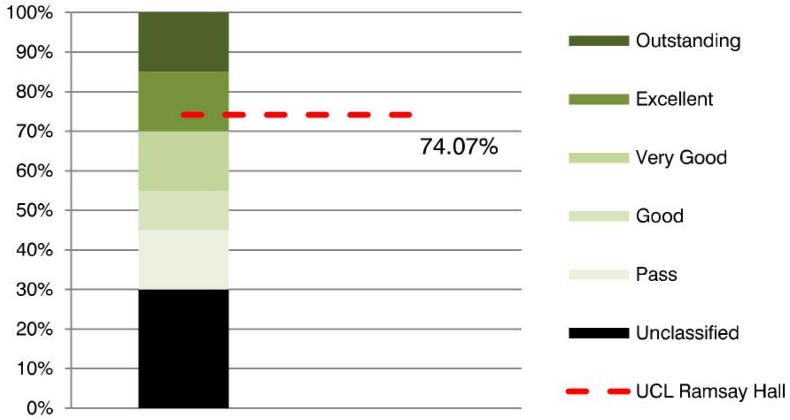


**Figure 16: BREEAM Environmental Weightings**

A BREEAM pre-assessment has been completed for the Ramsay Hall redevelopment of the design by a registered BREEAM "Accredited Professional". Given the scale of the extension and refurbishment (including both structural alterations and new building services) the scheme has been appraised against the BREEAM 2008 Education assessment, as it is a refurbishment of an existing building. The project has been lodged as such with the BRE and BREEAM 2008 was the most recent at the time of the submittal.

Given the high sustainability aspirations of UCL and focus of the design team, an **Excellent** pre-assessment score of **74.07** has currently been achieved.

This is comfortably within the banding of Excellent (>70%). The main features represented in the pre-assessment are as follows (the full BREEAM tracker document is attached as an Appendix):

- Appointment of a BREEAM Accredited Professional.
- Appointment of a contractor registered on the Considerate Contractors scheme.
- Wide implementation of stakeholder participation.
- Integration of cycle parking within the site.
- Achievement of high daylight factor for visual comfort.
- Implementation of a natural ventilation strategy backed up by thermal modelling.

- Achievement of 6 credits under Ene01 for reduction of carbon emissions equivalent to 25% reduction relative to Part L 2013.
- Significant sub-metering proposed for energy and water (during both construction and operation).
- Specification of low water use fittings.
- Design proposal for BRE green guide A rated materials.
- Construction waste to be targeted for reduction.

## 10 CONCLUSIONS

The current design achieves approximately 6% improvement on the $CO_2$ TER based on Building Regulations Part L 2013.

The current design will therefore not achieve the UCL target of a 25% improvement on the $CO_2$ target emissions rating. It is important to note however that the achievable improvement level is significantly limited by the efficiency of the existing fabric and the likely air permeability. Despite this, the proposed design includes a number of features targeted at reducing the energy demand and, therefore, the carbon emissions of the building:

- Maximising the use of passive ventilation.
- Use of heat recovery ventilation .
- New LED lighting and lighting control.
- High performance glazing.
- Boilers replaced with condensing boilers.
- EPC rating of ‘B’.
- New CHP.
- Automatic controls.

With the current level of improvement over Part L 2013 six credits are targeted under the Ene01 criteria. This is equivalent to the minimum pre-requisite to achieve an ‘Excellent’ rating in the 2008 Education assessment. With these levels applied to the design it is targeted to achieve 74.07%, which is still comfortably above the excellent threshold of 70%.