Polygon Open Space Residential, Central Somers Town

CST Plots 2, 5 and 6 Housing - Sustainability Statement for Planning Submission

Rev D Issue

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MAX FORDHAM

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1.0 EXECUTIVE SUMMARY

This document reports the sustainability requirements for three blocks at the Central Somers Town development plan. The blocks are as follows:

- Plot 2 – Charrington Street Housing – 35no apartments
- Plot 5 – Purchese Street Housing North and Community Hall – 20no apartments
- Plot 6 – Purchese Street Housing South -14no apartments

This report describes the steps taken to meet the requirements of Building Regulations, Camden Council CPG3 Sustainability Guide, and the requirements of the London Plan.

The first step being passive and energy efficiency measures such as upgraded building fabric: insulation and air tightness. The second step is connecting to the local CHP heat network. The third step is the application of appropriate renewables, in this case Photovoltaic panels.

The following are the summarised results for each apartment.

Plot 2	TonnesCO2/year	%
Savings from Energy Reduction	0.17	1.0%
Savings from CHP	6.41	15.5%
Savings from renewables - 117m^2 Photovoltaic panels	7.89	19.1%
Total Cumulative Savings	14.47	35.1%
London Plan Target Savings	14.43	35%
Annual Surplus	0.04	
Camden CPG3 Target by renewables	6.93	20% of energy consumption by renewables
Element of energy consumption by renewables	7.89 (of 34.64)	22.8%

Plot 5	TonnesCO2/year	%
Savings from Energy Reduction	-0.63	-2.5%
Savings from CHP	4.58	18.5%
Savings from renewables - 71m^2 Photovoltaic panels	4.80	19.4%
Total Cumulative Savings	9.38	37.9%
London Plan Target Savings	8.67	35%
Annual Surplus	0.08	
Camden CPG3 Target by renewables	4.16	20% of energy consumption by renewables
Element of energy consumption by renewables	4.8 (of 20.82)	23.1%

Plot 6	TonnesCO2/year	%
Savings from Energy Reduction	0.33	1.9%
Savings from CHP	3.22	17.8%
Savings from renewables - 45m^2 Photovoltaic panels	3.04	16.8%
Total Cumulative Savings	6.59	36.5%
London Plan Target Savings	6.32	35%
Annual Surplus	0.27	
Camden CPG3 Target by renewables	2.90	20% of energy consumption by renewables
Element of energy consumption by renewables	3.04 (of 14.51)	20.9%

1.1 Unregulated Loads

Plot 2

	TonnesCO2/year
Appliances	37.22
Cooking	7.25

Plot 5

	TonnesCO2/year
Appliances	21.40
Cooking	4.14

Plot 6

	TonnesCO2/year
Appliances	15.74
Cooking	2.95

2.0 INTRODUCTION

This document reports the sustainability requirements for three blocks at the Central Somers Town development plan. The blocks are as follows:

- Plot 2 – Charrington Street Housing – 35no apartments
- Plot 5 – Purchese Street Housing North and Community Hall – 20no apartments
- Plot 6 – Purchese Street Housing South -14no apartments

This report addresses the sustainability requirements for a Planning Submission of:

- Camden Council Document CPG3: Sustainability 2013
- Supplementary Planning Guidance, London Plan 2011 Implementation Framework

The document should be read in conjunction with all other documentation submitted by both the Plot 2/5/6 design team and the masterplan design team. Other contributors are referenced in this document and their submissions should be referred to alongside this report.

3.0 SUSTAINABILITY STRATEGY

3.1 Energy and CO_2 Emissions

Please refer to Energy Strategy Section of this report for details of how the proposals for Plots 2, 5 and 6 have met the local and national requirements.

3.2 Water Efficiency

CPG3 requires that Code 4 water consumption target of 105l/person.day is met.

The update to the London Plan will require that 105l/person.day is met.

The council requires that all developments over 10 units or 1000m² should include grey water recycling if feasible.

There are a number of methods to reduce the consumption of drinking quality water for non-potable uses:

- Reducing water consumption – we should try to reduce the volume of water consumed by specifying low flow sanitaryware fittings and white goods.
- Rainwater harvesting – collecting rainwater to be used for irrigation, laundry and flushing toilets.
- Water Recycling – collecting drainage water from baths, showers and wash basins to be reused for flushing toilets and laundry will further offset demand of drinking quality water.

Reducing Water Consumption
The target for water consumption is 105 litres per person per day. Using the BRE Water Efficiency Calculator as provided by the DCLG we have applied the following water consumption rates:

- Dual flush WC's with 4/2.6l per flush
- 5l/minute maximum flow for all taps
- 1no 140l bath
- 8l/minute maximum shower flow rate
- 0.8litre per place setting consumption for dishwasher
- 7.4kg/load washing machine

Based on these rates we have a100 l/day water consumption per person. Output of calculator as follows:

WATER EFFICIENCY CALCULATOR FOR NEW DWELLINGS - (BASIC CALCULATOR)

	House Type:	Type 1		Type 2		Type 3		Type 4	
	Description:	All apartments							
Installation Type	Unit of measure	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day	Capacity/ flow rate	Litres/ person/ day
Is a dual or single flush WC specified?		Dual		Select option:		Select option:		Select option:	
WC	Full flush volume	4	5.84		0.00		0.00		0.00
	Part flush volume	2.6	7.70		0.00		0.00		0.00
Taps (excluding kitchen and external taps)	Flow rate (litres / minute)	5	9.48		0.00		0.00		0.00
Are both a Bath & Shower Present?		Bath & Shower		Select option:		Select option:		Select option:	
Bath	Capacity to overflow	140	15.40		0.00		0.00		0.00
Shower	Flow rate (litres / minute)	8	34.96		0.00		0.00		0.00
Kitchen sink taps	Flow rate (litres / minute)	5	12.56		0.00		0.00		0.00
Has a washing machine been specified?		Yes		Select option:		Select option:		Select option:	
Washing Machine	Litres / kg	7.4	15.54		0.00		0.00		0.00
Has a dishwasher been specified?		Yes		Select option:		Select option:		Select option:	
Dishwasher	Litres / place setting	0.8	2.88		0.00		0.00		0.00
Has a waste disposal unit been specified?		No	0.00	Select option:	0.00	Select option:	0.00	Select option:	0.00
Water Softener	Litres / person / day	0	0.00		0.00		0.00		0.00
	Calculated Use		104.4		0.0		0.0		0.0
	Normalisation factor		0.91		0.91		0.91		0.91
Code for Sustainable Homes	Total Consumption		95.0		0.0		0.0		0.0
	Mandatory level		Level 3/4		-		-		-
Building Regulations 17.K	External use		5.0		5.0		5.0		5.0
	Total Consumption		100.0		0.0		0.0		0.0
	17.K Compliance?		Yes		-		-		-

Rainwater Harvesting
A small roof for a large internal floor area over a number of floor reduces the efficiency and practicality of rainwater harvesting. The Camden Planning Guide requires that buildings with gardens or landscaped areas requiring regular maintenance to be fitted with water butts.

Water butts will be provided to Plots 5 and 6 as the Community Garden is directly adjacent to these blocks.

Grey Water Recycling
The Camden Planning Guidance requires that the feasibility of a greywater system is to be investigated for each scheme as plots 2, 5 and 6 are all over the threshold of 10 units.

The feasibility is to be judged on the following considerations:

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

There are no technical feasibility considerations expressed in the Camden Planning Guidance to be used for justification of how appropriate such a system is in any particular application however, our primary concern is the increased maintenance that might arise from using such a scheme in a communal domestic property. There is no control as to what is poured down bath/sink drains in a private residence (oil, soaps, vomit, bodily fluids, organic matter, chemicals from cosmetics etc) resulting in increased maintenance costs and system downtime. This should be considered by the building owner.

Feasibility Assessment
To justify feasibly on a cost basis the following Thames Water costs were used:

- Volume water charge: £1.2629/m³
- Volume waste charge: £0.7943/m³

Grey water collection:

Using the BRE Water Efficiency Calculator it is calculated that total potential grey water collection is 60 litres per person per day, whereas the total potential grey water demand is 36 litres per person per day.

On this basis it is assumed that 36l/person per day can be offset by greywater recycling, or 13m³ per person per year. This equates to a 34% reduction in consumption of drinking quality water.

Reducing mains water consumption by 13m³ per year results in an offset of £26.70 per person per year.

Financial Assessment
We assume that there will be two grey water recycling plants:

- One serving Plot 2, assumed occupancy 100 people (fully occupied-best case)
- One serving Plots 5 and 6, assumed occupancy 123 people (fully occupied best case)

The following system costs are based on quotations from a grey water system manufacturer plus additional costs taken from SPONS for:

- Quotation for central plant as given by manufacturer (Waterscan)
- Plant room construction area (£1400/m² as given by QS)
- Additional collection drainage and distribution pipework (from SPONS)

Plot 2
The total cost of the installation over and above a typical drainage and water system is £64,000.

The annual maintenance costs given by the manufacturer is £800 per year for an annual visit to clean the filter.

The annual water saving for all of Block A is 1,320m³ per year or £2,710 per year.

On this basis the saving to the owner/maintainer of the building is zero as they do not benefit from the installation.

The saving to the occupiers of the 33 apartments in the building is £1,910 per year in total assuming the maintenance charge is passed on by the maintainer of the system to the tenants/owners of the apartments by way of service charge.

The 10 year saving is £19,100.

The simple payback is of the order of 33 years.

On this basis we would recommend that the system is not financially feasible for Plot 2.

Plots 5 and 6 Combined
The total cost of the installation over and above a typical drainage and water system is £65,000.

The annual maintenance costs given by the manufacturer is £800 per year for an annual visit to clean the filter.

The annual water saving for all of Plots 5 and 6 is 1,620m³ per year or £3,370 per year.

On this basis the saving to the owner/maintainer of the building is zero as they do not benefit from the installation.

The saving to the occupiers of the 31 apartments in the building is £2,540 per year in total assuming the maintenance charge is passed on by the maintainer of the system to the tenants/owners of the apartments by way of service charge.

The 10 year saving is £24,400

The simple payback is of the order of 26 years.

On this basis we would recommend that the system is not financially feasible for Plots 5 and 6.

3.3 Surface Water Run Off

Please refer to separate report by Civil Engineer

3.4 Materials

Please refer to Architects' Design and Access Statement

3.5 Waste

Please refer to Architects' Design and Access Statement

3.6 Air Pollution

Please refer to Air Quality Assessment by others

3.7 Light Pollution

External Lighting for these schemes will be very limited. All external lighting associated with Plots 2, 5 and 6 will be designed in accordance with ILE Guidance Notes for the Reduction of Obtrusive Light assuming the site to be E3 category.

All external lighting for the masterplan is contained in the masterplan reports.

3.8 Noise Pollution

Refer to acousticians report.

3.9 Health and Wellbeing

Please refer to Architects' Design and Access Statement

3.10 Daylighting

Optimisation of daylighting and glazing
Glazing has a significant impact on the control of the internal environment. There are three things to consider when optimising the fenestration for good control of internal environment:

- Glazing has a poor insulation quality and so allows heat to escape
- Glazing is semi-transparent to infra-red radiation – glass allows heat into the space and can contribution to overheating during the summer
- Glazing can be used for beneficial passive solar gain during the winter

The total area of glass is important when trying to reduce heat loss through glass, and reduce solar gain.

Location of glass is important when trying to reduce overheating during summer and optimise passive solar gain in winter, and also optimise daylight to achieve a good quality space and reduce electricity bills from the use of artificial lighting.

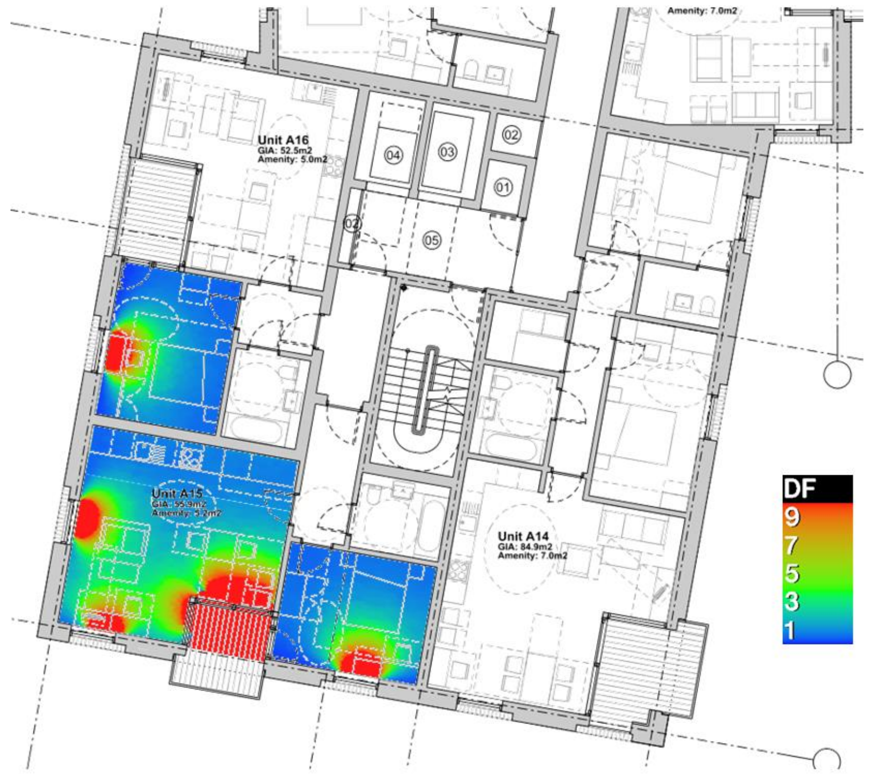
The Part L notional model provides 25% of internal floor area as glazed area spread across all external facades.

Our target is to have no more than 30% of floor area as glazed area. Positioning will be optimised for good daylight, to maximise views and to allow for trees to provide shading during the summer.

Daylight modelling results

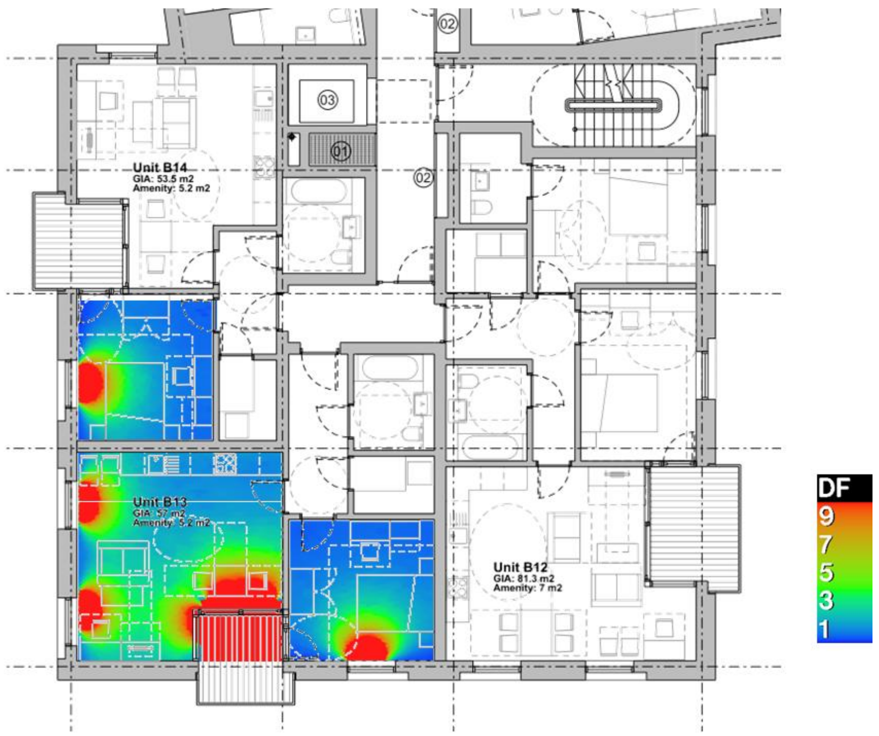
Element	Value
Wall Reflection	0.6
Floor Reflection	0.3
Ceiling Reflection	0.7
Window Transmission	0.7

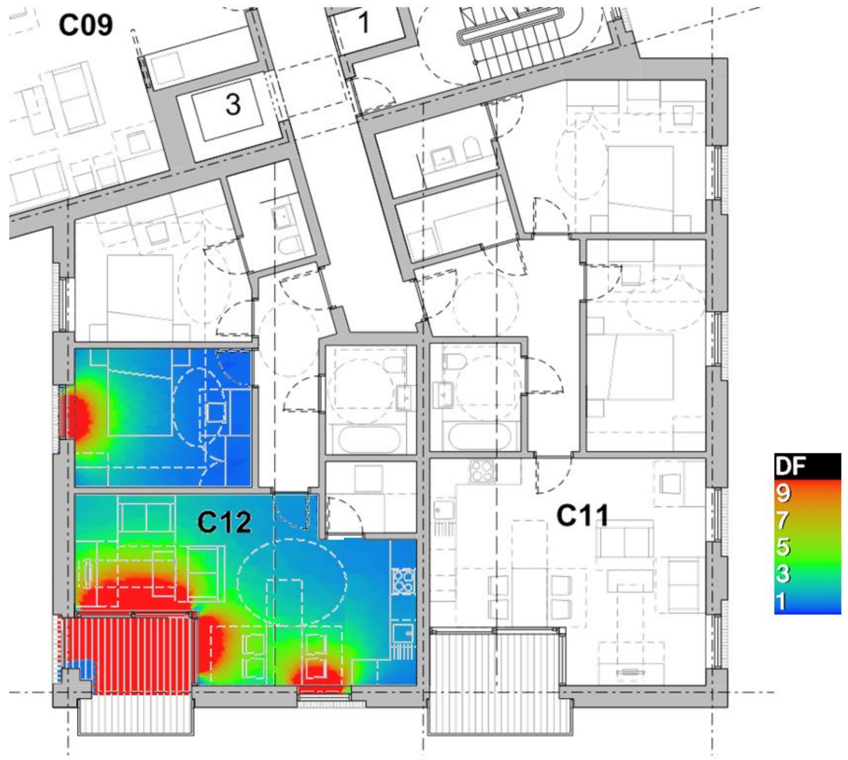
Space	Avg Daylight Factor Target - CfSH (%)	Plot 2 Unit A15 (%)
Kitchen	2	0.85 ✗
Living Area	1.5	4.47 ✓
Home Office	1.5	5.03 ✓
West Bedroom	N/A	1.97
East Bedroom	N/A	2.13



Space	Avg Daylight Factor Target - CfSH (%)	Plot 5 Unit B13 (%)
Kitchen	2	2.17 ✓
Living Area	1.5	4.40 ✓
Home Office	1.5	3.62 ✓
West Bedroom	N/A	2.12
East Bedroom	N/A	2.04

Space	Avg Daylight Factor Target - CfSH (%)	Plot 6 Unit C12 (%)
Kitchen	2	1.51 ✗
Living Area	1.5	4.48 ✓
Home Office	1.5	N/A
West Bedroom	N/A	2.32





3.11 Overheating

The London Plan Chapter 5 – 'London's Response to Climate Change' refers, in Policy 5.9 to overheating. This is in relation to climate change and the specific amplified impact that this will have on the London Urban Heat Island. The proposed site sits outside of the London Central Activities Zone and is situated on a green space with vegetation.

We have used CIBSE TM 52 as an assessment tool to anticipate the likelihood for overheating using future predicted climate data for Heathrow, as this is the most applicable to our geographical location in reference to the Central Activities Zone. It is not our intention to provide mechanical cooling to residential units.

CPG3 requires consideration of the impact of climate change and gives advice on how to combat it.

The proposed site includes significant vegetation and overshading by trees. The proposed building fabric is highly insulated to prevent penetration of heat, and balconies are semi inset to provide additional shading.

Extensive opening areas to windows have been provided to allow purge ventilation and all apartments have dual aspects to provide cross flow of air through living rooms and bedrooms to make the most of wind pressure from different directions.

CIBSE TM52

The latest guidance from CIBSE (Chartered Institute of Building Services Engineers) on the subject of overheating is CIBSE Technical Memorandum 52 (TM52). This sets requirements for modelling overheating in buildings, based on the CIBSE Design Summer Year (DSY) which simulates a typical "hot" year.

TM52 (2013) provides a methodology to assess 'Adaptive Thermal Comfort'. It is based on the comparison between the predicted room temperature and a maximum acceptable room temperature calculated from the 'running mean' of the outdoor temperature (T_{rm}). The running mean places greater weight on the temperature for days closer to the present as these have more influence on a person's comfort levels. This means that the overheating threshold is dynamic and is based on the weather file utilised.

TM52 is based on the latest research into the rate at which people adapt to changes in climate. As a result, the temperature criteria vary through time. During a cool spell of weather the acceptable temperature range decreases, whereas in a hotter period, when people are acclimatised, warmer internal temperatures are permitted. The internal target temperature is based on the running mean of the external temperature.

TM52 sets out three criteria, with a 'pass' dependent on meeting two out of the following three criteria:

Criterion 1 - Hours of Exceedance (H_e):

The number of hours the predicted operative temperature exceeds the upper limit of the range of acceptable operative temperatures (T_{max}) by 1K, or more, does not exceed 3% of occupied hours, during the five summer months (May-September).

Criterion 2 - Weighted Exceedance (W_e):

The sum of the weighted exceedance for each degree Kelvin above T_{max} (1K, 2K and 3K) is ≤ 6, where:

$W_e = \Sigma H_e$ (1, 2, 3) *(ΔT) (1, 2, 3) and

$\Delta T = (T_{op} - T_{max})$, rounded to a whole number i.e. [0 °C < 0.5 °C ≥ 1 °C].

Therefore, the severity of the instances overheating must be limited with worse instances of overheating occurring much less frequently than minor instances.

Criterion 3 - Threshold/Upper Limit Temperature (T_{upp}):

The measured/predicted operative temperature should not exceed the Tmax by 4K or more at any time, where T_{max} + 4K is called the upper limit (T_{upp}). This means that the temperature shall never be significantly higher than the current expected discomfort temperature.

Weather Data

The external weather data used in the simulations places a significant role in the building's performance with respect to the above criteria. The current standard weather datasets in the UK are the Test Reference Years (TRYs) and Design Summer Years (DSYs), provided by CIBSE.

They are hourly weather files based on past observations (1981–2012) and are available for 14 locations in the United Kingdom, including London. The TRYs are average years, and so are appropriate for energy performance calculations. The DSYs of an actual 1-year sequence of hourly data selected from the 20-year data sets to represent a year with a hot summer and so are appropriate for thermal comfort assessments.

Urban centres such as London tend to experience more intense and frequent summer hot events, exacerbated by the urban heat island (UHI) effect. The UHI effect is a result of the dense built up of urban centres and the lack of green areas and manifests as a temperature difference between the urban centres and their rural surroundings.

The Greater London Authority - recognising the intensity of the UHI effect in London and its impact on the risk of overheating, especially in dense urban locations - funded a study to address the need to introduce the UHI effect in building design. The results of the study were made available by CIBSE as 'TM49 Design Summer Years for London' with the accompanying DSY datasets for building thermal simulation. This means that instead of having a single DSY for London, three DSYs are now available capturing the local climate in three different London sites: London Weather Centre, Heathrow and Gatwick (urban, semi-urban, and rural) and for three years (1976, 1989 and 2003) of varying severity of hot events.

As well as accounting the the potential increased risk of overheating due to the urban heat island effect, the use of these weather years will also provide some insight into how a building may perform in a climate where significant warm-weather events become more frequent.

For our overheating assessment, we tested the building under the London Heathrow CIBSE TM49 DSY weather files.

Overheating Modelling Results

The results of our overheating analysis against the TM52 criteria using the TM49 weather data are summarised below.

In all three cases, it can be seen that Criteria 1 is satisfied. This means that the indoor temperature exceeds the T_{max} (by at least 1K) for less than 3% of the occupied hours, during the summer months. Under the earlier DSYs, Criteria 3 was satisfied throughout, which means that the indoor temperature does not exceed the upper limit (T_{upp}) at any point.

However, under the 2003 DSY, it was found that all occupied spaces fail Criteria 2 and 3. Further investigation into the results showed that although the upper limit temperature (T_{upp}) was exceeded, it was only during the times when this threshold was particularly onerous. Figures 3.1, 3.2 and 3.3 overleaf look at these instances in more detail.

	1976			1989			2003		
Criterion	**1**	**2**	**3**	**1**	**2**	**3**	**1**	**2**	**3**
Plot 2	✓	✗	✓	✓	✗	✓	✓	✗	✗
Plot 5	✓	✗	✓	✓	✗	✓	✓	✗	✗
Plot 6	✓	✗	✓	✓	✗	✓	✓	✗	✓

Evaluation of Results

While the plots perform well against the 1976 and 1989 weather years, the failure of Plots 2 and 5 against the 2003 weather year could give some cause for concern.

As a result, we have looked in detail at the buildings performance in this year, both in the hope of highlighting potential areas for improvement, but also to understand what coincidence of circumstance has led to this failure.

The key temperature variables used by TM52 to assess overheating can be summarised as follows:

- T_{od}: daily mean temperature.
- T_{rm}: the exponentially weighted running mean of the daily mean outdoor air temperature.
- T_{comf}: comfort temperature – this is based on T_{rm}, with more recent experiences being more influential.
- T_{max}: maximum acceptable temperature, calculated by adding a fixed ΔT to T_{comf} depending on the building type.
- T_{upp}: absolute upper limit, which is 4K above T_{max}.

The profiles for these variables over the summer of the 2003 weather year are illustrated in Figure 3.1. As can be seen, there are instances when the upper limit temperature (T_{upp}) is significantly lower than the outdoor dry bulb temperature – this is illustrated in the graph around August, where the maximum temperature limit is 3.5°C lower than the outdoor dry bulb temperature. This means that in these instances, one would have to maintain an indoor temperature of at least 3.5°C below the external temperature in order to pass Criterion 3 of the TM52. In addition, failure of criterion 3 makes passing criterion 2 extremely difficult to pass – for a W_e of at least 4K has already been accrued from that one single hour.

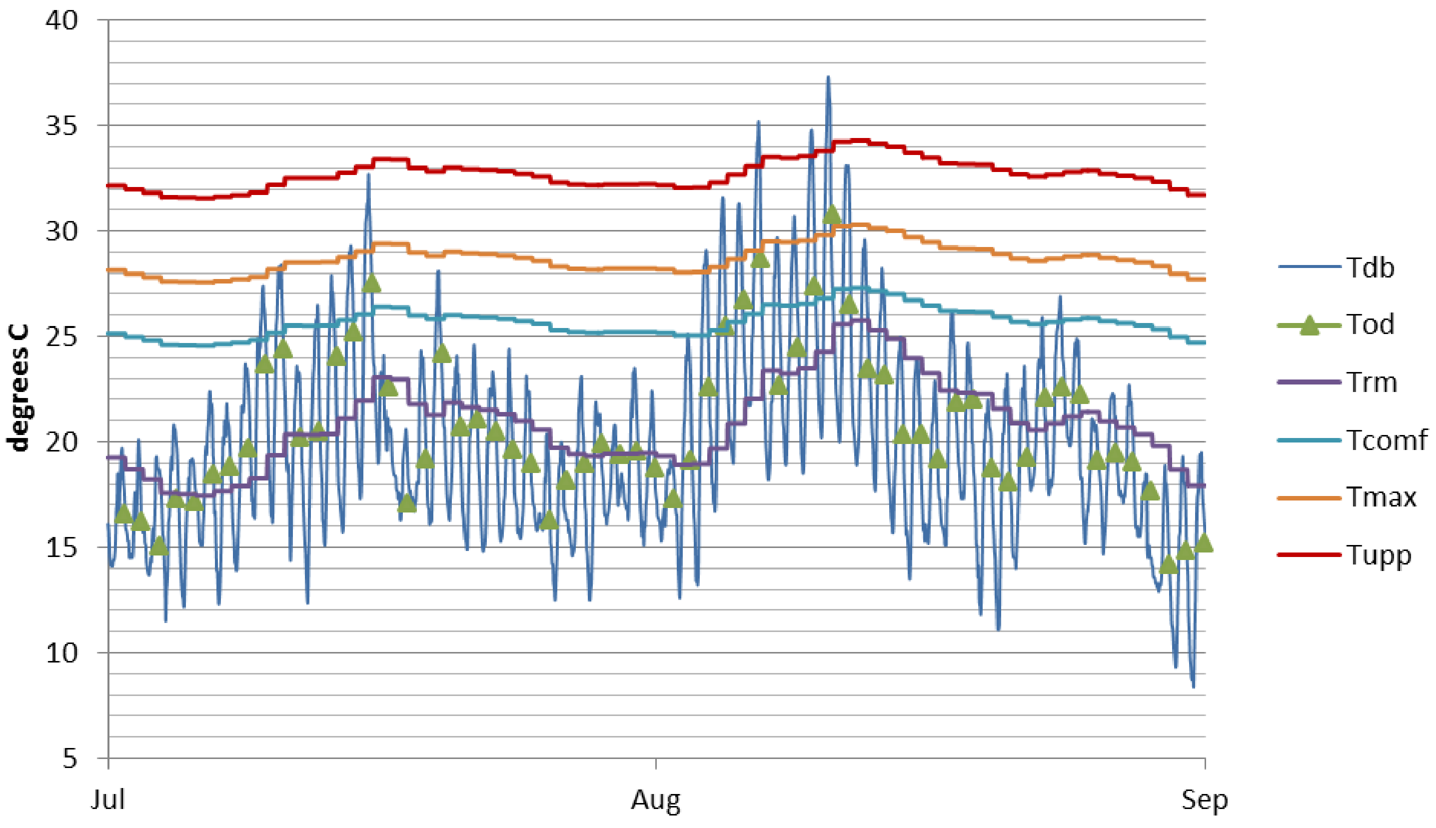
Since the living spaces are intended to be naturally ventilated, maintaining air temperatures significantly below the external on these exceptionally warm days is extremely difficult.

Figure 3.2 illustrates the indoor and outdoor temperature profile for the spaces failing Criterion 3 on the hottest day of the 2003 DSY. Despite the indoor temperature being hotter than the threshold (T_{upp}), and thus failing criterion 3 of TM52, it is still lower than the outdoor temperature for most of the occupied hours. Therefore, in the event that an exceptionally hot day such as this does occur, these naturally ventilated spaces are still capable of maintaining relatively low - in many cases below external - internal temperatures.

The ventilation rates shown in Figure 3.3 should also be noted – as can be seen, flow rates above 1000l/s are achieved throughout the hottest hours of the day – equivalent to over 40ACH. This level of ventilation will result in a significant reduction in perceived temperature due to air speed, and allows the rooms to reduce their temperatures more rapidly once the outdoor temperature starts to decrease.

Investigations have been made into the addition of external blinds, which have proved effective in providing additional overheating mitigation when combined with internal curtains. However, the maintenance issues and costs associated with this form of shading provides little justification for their use, particularly when battling the onerous criteria of the 2003 weather year.

In conclusion, it is felt that failure of criterion 3 in the 2003 weather year does not represent an overheating risk for a naturally ventilated living space, when full occupancy throughout the summer is assumed. It is felt that the performance of the natural ventilation system demonstrated should ensure that in all realistic situations temperatures will be maintained within reasonable limits.



F igure 3.1 Graph of outdoor dry bulb temperature (T_{db}) with CIBSE TM52 parameters (2003 DSY)

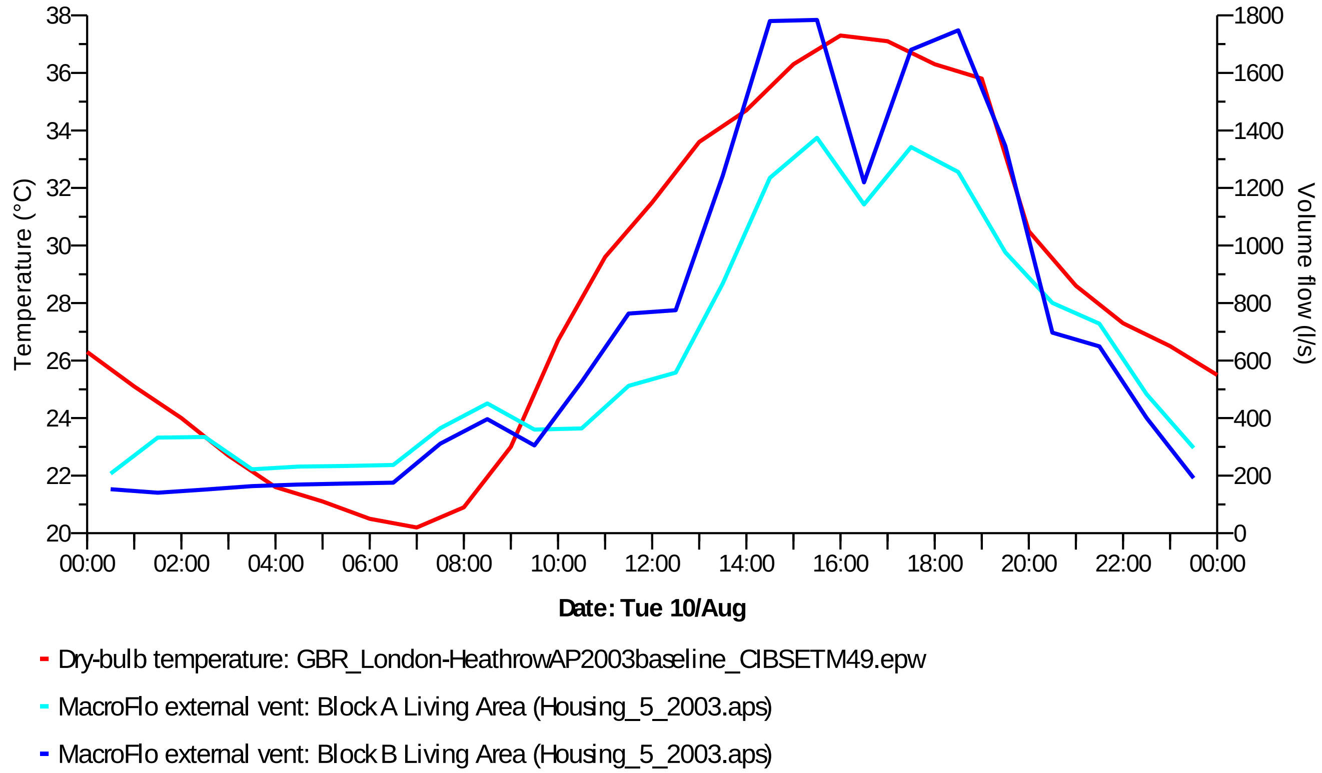


Figure 3.3 – Peak Day Graph. Outdoor dry bulb temperature (T_{db} in red) with external ventilation rate (cyan for Plot 2 and blue for Plot 5) for August 10th (2003 DSY)

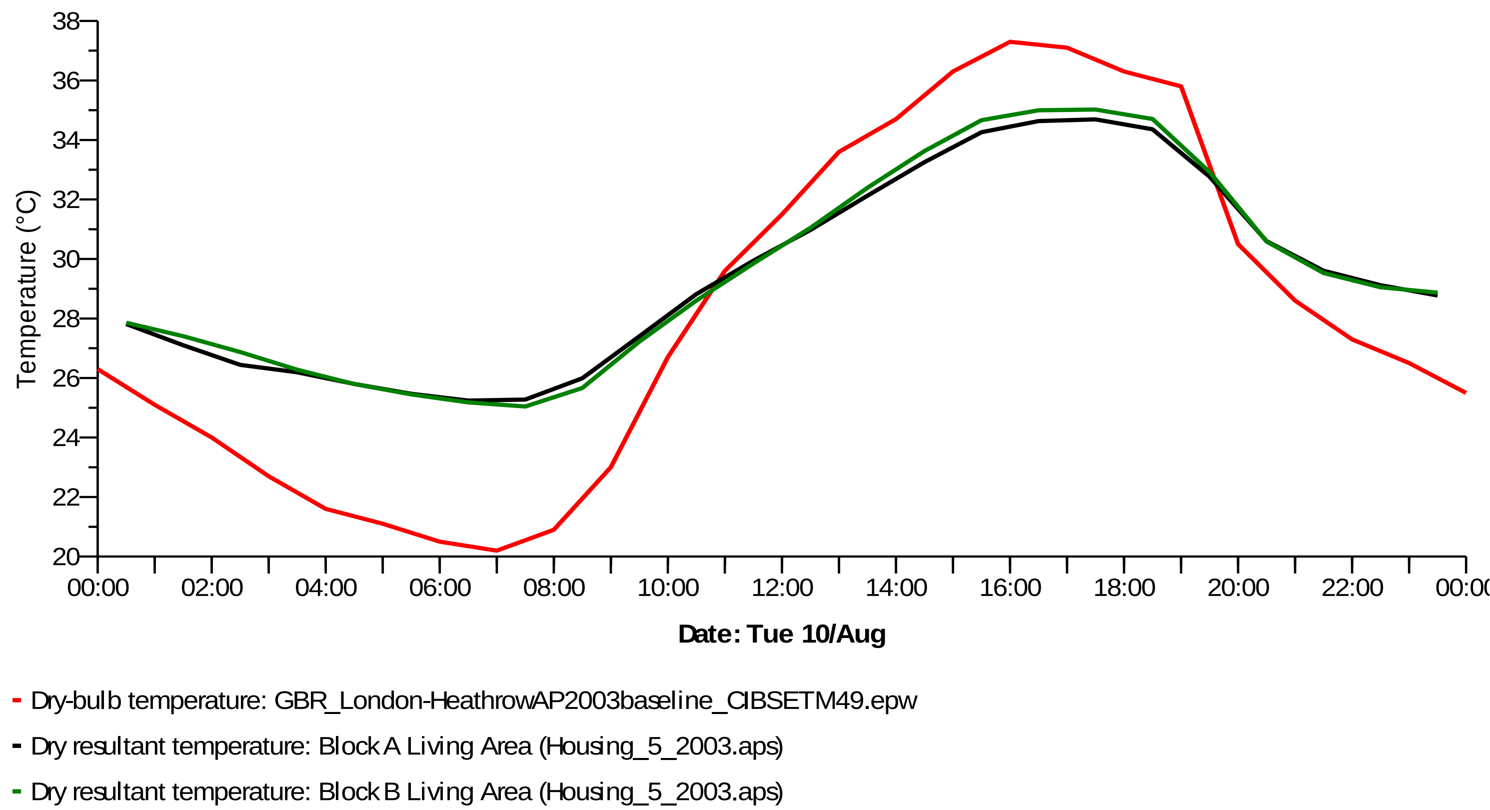


Figure 3.2 – Peak Day Graph. Outdoor dry bulb temperature (T_{db} in red) with indoor dry resultant temperature (T_{op} in black for Plot 2 and green for Plot 5) for August 10th (2003 DSY)

3.12 Management

Please refer to Draft Construction Management Plan produced by BAM Construction.

3.13 Ecology and Land Use

Please refer to Ecology Report produced by Penny Anderson Associates Ltd.

3.14 Transport

Please refer to transport Assessment produced by Civic Engineers

4.0 ENERGY STRATEGY

4.1 Introduction

This section of the report addresses the specific requirements for a development with the jurisdiction of Camden Council.

4.2 Building Regulations 2010 – Part L 2013 (England)

CO2 emission rate calculations
Part L of the Building Regulations relates to energy usage and carbon emissions. A Target Emission Rate (TER) is calculated based on a notional building of the exact same size, location and orientation as the proposed building. In order to meet building regulations the calculated actual Dwelling Emissions Rate (DER) – for dwellings – must be lower than the TER. Dwellings must also meet a Target Fabric Energy Efficiency (TFEE), which sets a standard for the fabric efficiency of the dwelling.

In the case of a building containing multiple dwellings, compliance may be demonstrated by

a) **Either** every individual dwelling has a DER that is no greater than the individual dwellings corresponding TER
b) **Or** the average DER for the whole building is no greater than the average TER

Consideration of high-efficiency alternative systems
The technical, environmental and economic feasibility of using high-efficiency alternative systems must be taken into account. These systems should include decentralised energy supply based on energy from renewable sources.

4.3 GLA London Plan

The Government's Climate Change Act 2008 sets a target of reducing the UK's greenhouse gas emissions by 80% compared to 1990 levels by 2050. In order to help achieve this target the Mayor has set London the target of reducing its carbon dioxide emissions by 60% compared to 1990 levels by 2025. **Policy 5.2** states that development proposals are expected to contribute to meeting this target by achieving a BER that is 35% below the Building Regulations Part L 2013 TER. All new developments must consider ways to reduce their carbon emissions. The London Plan requires that the consideration of carbon emissions reducing measures to be used by the development follow their Energy Hierarchy as depicted in **Figure 4.1**.

Be Lean first encourages a reduction in energy use. This can be achieved through both passive and active measures. Passive measures include improvements to the building fabric and ensuring the design of the building minimises solar gains and thus reduces the need for cooling. Active measures include using the most efficient building services.

Be Clean ensures energy is supplied efficiently by requiring the consideration of connecting to a district heating network or using cogeneration for efficient on-site energy production.

Finally **Be Green** encourages the use of renewable energy to offset carbon emissions that would otherwise occur from the use of natural gas or electricity from the grid.

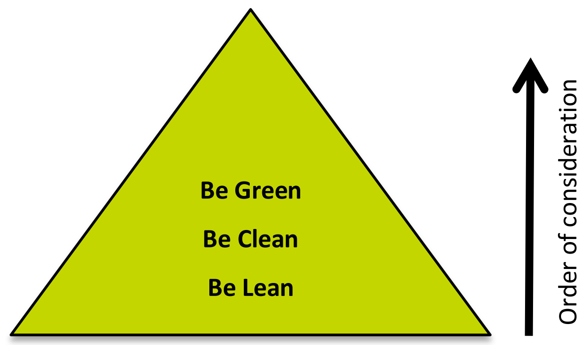


Figure 4.1 **The Energy Hierarchy from the London Plan**

In line with the London Plan Policy 5.2, a detailed Energy Assessment will be produced that demonstrates how the targets for carbon dioxide emissions reduction are to be meet within the framework of the aforementioned energy hierarchy..

With regards to community energy schemes, **Policy 5.6** of the London Plan states that proposals should select energy systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks
2. Site wide CHP network
3. Communal heating and cooling

4.4 Camden Council

Camden's Local Development Framework Core Strategy 2010-2015 sets out the council's strategic planning policy. Core Strategy 13 relates to the subject of LZC technologies.

CS13 – Tackling climate change through promoting higher environmental standards
This policy includes such strategies as:

- Minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing the energy hierarchy (**Figure 4.1**).
- Implementing local energy networks.
- Protecting existing local energy networks.

This policy is supported by Development Policy 22 and Camden Planning Guidance 3 Sustainability.

DP22. Promoting sustainable design and construction
The Council will promote and measure sustainable design and construction by expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and encouraging Code Level 6 (zero carbon) by 2016. The requirement for achieving any level of Code for Sustainable Homes has been withdrawn with the exception of energy target and the water reduction target.

CPG3 Sustainability
This planning guidance document contains the following key messages:

- All developments are to be designed to reduce carbon dioxide emissions.
- Energy strategies are to be designed following the steps set out by the energy hierarchy.
- Decentralised energy could provide 20% of Camden's heating demand by 2020.
- Combined heat and power plants can reduce carbon dioxide emissions by 30-40% compared to conventional gas boiler.
- Where feasible and viable your development will be required to connect to a decentralised energy network or include CHP.
- There is a variety of renewable energy technologies that can be installed to supplement a development's energy needs.
- Developments are to target 20% reduction in carbon dioxide emissions from on-site renewable technologies.
- Developments should achieve 50% of the un-weighted credits in the Energy category (code for sustainable homes)

Energy Hierarchy
CPG3 sets out the route to reducing energy consumption using the three steps of the well understood energy hierarchy:

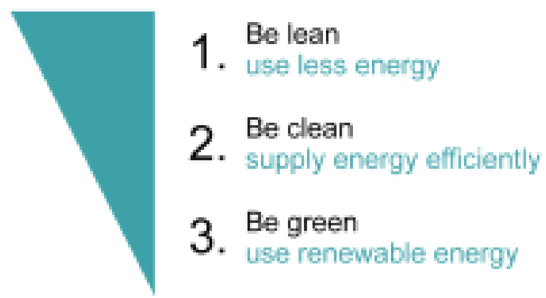


Figure 4.2 CPG3 Energy Hierarchy

The next sections describe how we have applied this approach.

4.5 Energy Efficiency – Be Lean – Building Fabric

The first step to reducing energy consumption is to reduce the amount of energy the building needs to function comfortably, particularly for heating and cooling. Passive measures will be taken to ensure the fabric is intrinsically protective of the internal environment holding heat within the fabric during winter and ensuring the spaces do not overheat during summer due to excessive solar gain.

Building Fabric Insulation

The elements that form the building fabric are the barrier between internal and external environmental conditions.

Building Regulations Approved Document Part L sets worst case minimum performance of insulation levels that cannot be dropped below. In addition to this, the overall building energy is modelled and compared against a 'notional' buildings performance; this notional building has parameters that exceed Part L minimum values. If we fail to meet these values, alternative, more expensive active energy reduction methods will need to be employed to pass Part L.

Beyond this is 'PassivHaus' which is a design strategy that looks to improve building fabric to such a level that passive methods such as solar gain can provide almost all the heating.

We will be looking to go beyond the PassivHaus standard insulation values for opaque elements to offset the poorer glass U-value selected. We will aim for a glazing U-value that exceeds the notional model. Beyond the selected glazing U-value glass requires specialist expensive materials and fabrication.

Element	Building Regulation Minimum	Notional Building Minimum	Passiv Haus Standard	Proposed U-values for dwellings
Roof W/m².K	0.25	0.18	≤0.15	**0.13**
Wall W/m².K	0.35	0.26	≤0.15	**0.10**
Floor W/m².K	0.25	0.22	≤0.15	**0.13**
Window W/m².K	2.2	1.6	≤0.8	**1.3**

Cold Bridging

Cold Bridging is the direct conduction of heat from inside to outside via structural elements. We are assuming that the Y-value of thermal bridges will not be worse than 0.08 $W/m^2.K$. The relies on the architect and structural engineer using Accredited Construction Details (ACD).

Infiltration

Building airtightness is the measure of how much external air enters the building through cracks and gaps in façade construction, window and door frames and interfaces between facades, roofs, and other elements and buildings.

Building Regulations Part L Limiting Value	Part L Notional Building Value	Proposed Design Value	
10	5	3	$m^3/m^2.hr@50Pa$

This will be tested on completion of construction as part of the Part L certification compliance.

4.6 Energy Efficiency – Be Lean – Ventilation

Once the building fabric has been optimised to reduce energy consumption we can address the 'active' mechanical and electrical systems that consume energy in order to provide a necessarily comfortable and healthy internal environment for occupants and for the building fabric.

Requirements

Each apartment requires ventilation in accordance with Building Regulations Approved Document F. Building Regulations define ventilation in two ways - 'background' and 'purge', both need to be provided.

Background ventilation is the minimum amount of ventilation necessary to keep rooms feeling fresh and control odour. This can be provided by trickle ventilators in the facades with mechanical extract in bathrooms and kitchens. The alternative is MVHR mechanical heat recovery ventilation.

Purge ventilation provides a higher rate of ventilation when required; it is primarily for control of heat build-up in warmer weather but also allows rapid ventilation and 'airing' of rooms.

Kitchens and bathrooms are sources of pollutants, mainly steam and smells and are controlled with extract ventilation to reduce moisture build up and for odour control.

Within modern apartment developments the two main sources of providing ventilation are continuous mechanical extract ventilation (CEV) and mechanical ventilation with heat recovery (MVHR). Natural ventilation is the third option for residential accommodation but cannot efficiently be integrated into multi-storey apartment buildings due to the requirements for vertical stacks so we have excluded this option from the outset.

Continuous Extract Ventilation

Figure 2.2 demonstrates the principle of continuous extract ventilation. Air is extracted from kitchens and bathrooms and drawn into the flats through trickle vents to the habitable rooms (living areas and bedrooms).

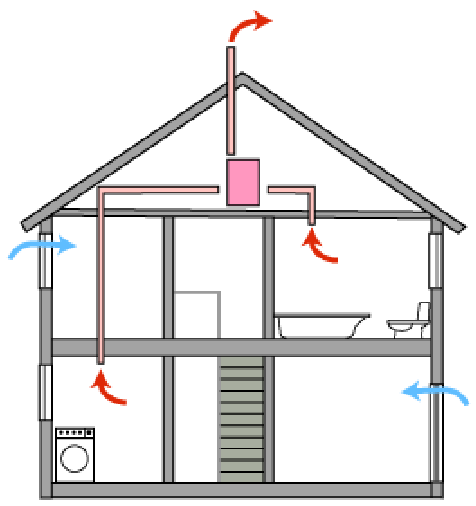


Figure 4.3 Continuous extract ventilation

To adopt this principle a central extract unit would extract from the kitchen area and from the bathrooms. Air would be exhausted from the building through discreet louvres built into the façade.

Mechanical Ventilation with Heat Recovery

Figure 2.3 illustrates the principle of MVHR. Air is extracted from kitchens and bathrooms in the same way as CEV but supply air is introduced mechanically. By extracting and supplying air from a central unit heat can be transferred from the outgoing air to the intake air reducing energy demand. A bypass can be provided for summer time use to prevent overheating.

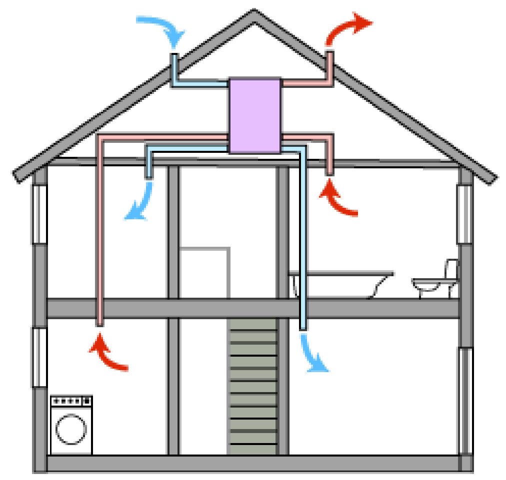


Figure 4.4 Mechanical ventilation with heat recovery

MVHR is installed in the same way as CEV a central unit would extract from the kitchen area and from the bathrooms. Supply make up air will be ducted direct to habitable rooms. Both intake and exhaust ventilation would be ducted through the building façade. The advantages and disadvantages of both systems are summarised below.

	CEV	MVHR
Advantages	✓Reduced ductwork over MVHR systems ✓Reduced capital cost	✓Constant supply of tempered fresh air, no draughts and improved fabric protection ✓Reduced running costs, contributes to meeting Part L and Planning energy requirements. ✓Simplifies window detailing, no trickle vents and improved overall air tightness ✓Improved acoustic separation from outside.
Disadvantages	×Requirement for trickle vents in windows ×Potential draughts through trickle vents in very cold weather	×Increased capital costs ×More ductwork to be integrated into the building. ×Requires machinery with ongoing maintenance

As an MVHR system reduces overall energy demand this reduces the requirement for bolt-on renewables to meet the London Plan target. As we have a small roof area in relation to overall internal floor area, MVHR allows for a reduced PV area. Without MVHR we may struggle to meet the 35% target.

In addition MVHR provides a constant fresh air rate without draught ensuring a healthy internal environment can be comfortably maintained which also contributes to building fabric longevity (reducing internal mould growth etc) in comparison to central extract with openings that may get blocked up by occupants.

Purge Ventilation
Purge Ventilation is provided for a number of reasons:

- Rapid ventilation to 'air' a space or to 'freshen' the space
- Rapid ventilation for odour removal
- Prevention of overheating, particularly during summer

Part F of the Building Regulations requires that four air changes an hour be available for purge ventilation.

To serve these purposes a large opening should be provided for rapid turnover of air. There are a number of considerations and details to get right to ensure rapid purge ventilation operates properly:

- Practical issues - consider the real effective opening, with modern thick wall constructions, a common problem is open very large windows into deep reveals resulting in very little opening area and so poor ventilation. Curtain or blinds can compromise either the limit of opening or reduce the airflow if drawn across an opening.
- Acoustic issues - acoustics are another important consideration, opening windows at night time can result in ingress of noise from busy streets.
- Security - opening windows or leaving balcony doors open overnight may leave properties vulnerable to burglary; this is not just a problem on ground and first floors.

A full acoustic survey is required to generate a 3D noise map of the site to allow a proper assessment of the impact of ambient noise. An initial assessment can be made using DEFRA's noise map:

Figure 4.5 Night Noise Map, Polygon housing

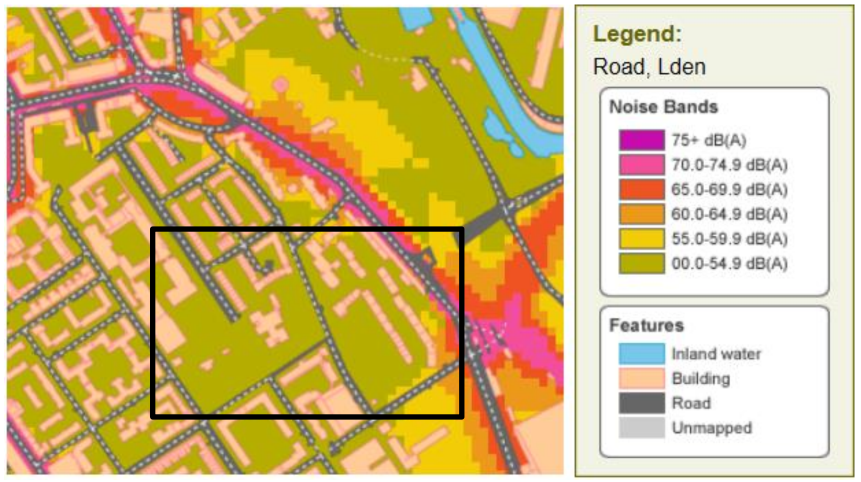


Figure 4.6 Day Noise Map, Polygon housing

BS8233-2014'*Guidance on Sound Insulation and Noise Reduction for Buildings*' gives details of indoor ambient noise levels for dwellings as shown in the table below:

Activity	Location	0700 to 2300	2300 to 0700
Resting	Living room	35 $dbL_{Aeq,16hr}$	-
Dining	Dining area	40 $dbL_{Aeq,16hr}$	-
Sleeping	Bedroom	35 $dbL_{Aeq,16hr}$	30 $dbL_{Aeq,16hr}$

It can be seen that external noise is at the low end of the spectrum during both day and night, the acousticians report gives further details. For this reason opening windows will generally be sufficient to provide purge ventilation.

4.7 Implementation of Passive and Active Measures (No District Heating or Renewables)

Due to the significant number of internal layout arrangement and fenestration arrangements there are few 'standard' apartments, the following table is a combined total however a full table of SAP outputs are included in Appendix 1.

The following table shows the Part L Target Emission Rate (TER) for each compared against the calculated Dwelling Emission Rate (DER) without renewables or District Heating but including, high efficiency fabric, MVHR and gas fire condensing boiler as a base case heat emitter.

Apt ref	Part L TER $TonnesCO_2/yr$	FSAP DER $TonnesCO_2/yr$
Plot 2	41.22	41.05

Apt ref	Part L TER $TonnesCO_2/yr$	FSAP DER $TonnesCO_2/yr$
Plot 5	24.77	25.40

Apt ref	Part L TER $TonnesCO_2/yr$	FSAP DER $TonnesCO_2/yr$
Plot 6	18.07	17.73

4.8 Decentralised Energy Networks and Combined Heat and Power

CPG3 demands that developments are to connect to a decentralised energy network unless it can be demonstrated that it is not technically feasible or financially viable. In addition it refers to the London Plans target of 25% of heat and power used in London to be generated through the use of localised decentralised heating and cooling networks.

Camden Council have recently installed a central boiler plant and distribution network in the local area which serves a number of local early 20th Century social residential housing in the area.

Figure 4.7 Existing and Proposed local Heat Network

- The Red line indicates existing buried district heating pipework
- The green block is Plot 2 (previously referred to as Lot 1 block A)
- The red blocks are Plots 5 and 6 (previously referred to as Lot 1 Blocks B and C)
- The orange pipework is proposed connections.

The central plant at the existing heat network is currently boilers only. There is a proposal to provide a CHP unit to come online in Q1 2017 which would be before Lot 1 is completed allowing us to factor it into our assessment and Planning Application.

The Engineer for the District Heating scheme (Arup) has advised the following figures be used for assessment of connecting Lot 1 residential to the district heating scheme with CHP:

Parameter	Value
CHP heat fraction	60%
Boiler heat fraction	40%
CHP thermal efficiency	39.5% (GCV)
CHP electrical efficiency	35.7% (GCV)
Boiler thermal efficiency	85%
Heat loss distribution factor	1.1
CEF of heating system	0.12kgCO_2/kWh delivered
Cost of delivered heat	4.2p/kWh delivered

4.9 Implementation of Passive Measures, Active Measures and Decentralised Energy Network

The following table shows the Part L Target Emission Rate (TER) for each compared against the calculated Dwelling Emission Rate (DER) without renewables but including, high efficiency fabric, MVHR and connection to the District Heating system using the assumptions above.

Apt ref	Part L TER TonnesCO_2/yr	FSAP DER TonnesCO_2/yr
Plot 2	41.22	34.64

Apt ref	Part L TER TonnesCO_2/yr	FSAP DER TonnesCO_2/yr
Plot 5	24.77	20.82

Apt ref	Part L TER TonnesCO_2/yr	FSAP DER TonnesCO_2/yr
Plot 6	18.07	14.51

It can be seen that without renewables, all apartments pass Part L with significant margins. The next stage is to apply appropriate renewables to ensure that each apartment will comply with the requirements of Camden Council and the London Plan:

- Camdens CPG3 requires that 20% of energy consumption is by renewables
- The London Plan requires that the current Part L Target Emission Rate is improved by 35%.

4.10 Renewables

After energy efficiency and decentralised energy considerations have been met, stage 3 of the energy hierarchy requires consideration of appropriate onsite renewables. The Council expects that a minimum of 20% reduction in carbon dioxide emissions through the use of on-site renewable energy generation will be realised.

CPG3 lists the following technologies that is recognises as 'renewable':

Technology	Short appraisal
Solar thermal Hot Water	Not appropriate for a site that will be connected to a district heating system – offsets some of the impact of the district heating provision
Photovoltaic Panels	Limited to roof area – appropriate so long as roof area can be provided to meet requirements
Ground Source Heat Pump	Not appropriate for a site that will be connected to a district heating system
Air Source Heat Pump	Not appropriate for a site that will be connected to a district heating system
Biomass heating and Power	Not appropriate for a site that will be connected to a district heating system
Wind Turbines	Not appropriate for an inner city site where wind distorts flow of wind and noise and shadow flicker is likely to be a problem

The London Plans target of 35% improvement over Part L 2013 TER will also be met using Photovoltaics if the passive and decentralised energy techniques do not meet the required target.

We will be providing Photovoltaic panels in order to achieve the 20% reduction target (and the 35% London Plan Target).

4.11 Implementation of Renewables

Adding renewables reduces the energy consumption further as follows for a selection of apartments for information:

Plot 2

Apt ref	London Plan target kgCO_2/m².yr	Camden CPG3 target kgCO_2/m².yr	PV area added m²	DER with PV kgCO_2/m².yr
A04 (85m²)	10.10	10.25	3.5	10.06
A05 (56m²)	10.44	10.76	2.5	10.40
A34 (102m²)	11.05	12.05	6.1	11.04

On the basis of the above (and the calculations presented in Appendix 1 for the entire block, a total of 117m² of Photovoltaic panel is to be provided for Block A in order to comply with The London Plan and with Camden Council policy. This assumes a minimum panel efficiency of 15%.

Overall the following DER is realised:

	Part L TER TonnesCO_2/yr	FSAP DER TonnesCO_2/yr	PV area required m^2
Plot 2	41.22	26.75	117

Refer to Appendix 1 for a summary of Block B outputs, a total of 71m^2 of PV is required in order to comply with The London Plan and with Camden Council policy. This assumes a minimum panel efficiency of 15%.

	Part L TER TonnesCO_2/yr	FSAP DER TonnesCO_2/yr	PV area required m^2
Plot 5	41.22	16.02	71

Refer to Appendix 1 for a summary of Block C outputs, a total of 45.2m^2 of PV is required in order to comply with The London Plan and with Camden Council policy. This assumes a minimum panel efficiency of 15%.

	Part L TER TonnesCO_2/yr	FSAP DER TonnesCO_2/yr	PV area required m^2
Plot 6	18.07	11.48	45

4.12 Summary of Results

Each block is demonstrated to pass the National and Local energy efficiency criteria, using a combination of:

- High efficiency building fabric
- Mechanical Ventilation with Heat Recovery
- District Heating with CHP
- Photovoltaic Panels

4.13 Plot 2

Plot 2	Total Tonnes CO2/yr
Baseline Part L TER	41.22
After energy demand reduction	41.05
After CHP	34.64
After Renewable energy	26.75

Plot 2	TonnesCO2/year	%
Savings from Energy Reduction	0.17	1.0%
Savings from CHP	6.41	15.5%
Savings from renewables - 117m^2 Photovoltaic panels	7.89	19.1%
Total Cumulative Savings	14.47	35.1%
London Plan Target Savings	14.43	35%
Annual Surplus	0.04	
Camden CPG3 Target by renewables	6.93	20% of energy consumption by renewables
Element of energy consumption by renewables	7.89 (of 34.64)	22.8%

4.14 Plot 5

Plot 5	Total Tonnes CO2/yr
Baseline Part L TER	24.77
After energy demand reduction	25.40
After CHP	20.82
After Renewable energy	16.02

Plot 5	TonnesCO2/year	%
Savings from Energy Reduction	-0.63	-2.5%
Savings from CHP	4.58	18.5%
Savings from renewables - 71m^2 Photovoltaic panels	4.80	19.4%
Total Cumulative Savings	9.38	37.9%
London Plan Target Savings	8.67	35%
Annual Surplus	0.08	
Camden CPG3 Target by renewables	4.16	20% of energy consumption by renewables
Element of energy consumption by renewables	4.8 (of 20.82)	23.1%

4.15 Plot 6

Plot 6	Total Tonnes CO2/yr
Baseline Part L TER	18.07
After energy demand reduction	17.73
After CHP	14.51
After Renewable energy	11.48

Plot 6	TonnesCO2/year	%
Savings from Energy Reduction	0.33	1.9%
Savings from CHP	3.22	17.8%
Savings from renewables - 45m^2 Photovoltaic panels	3.04	16.8%
Total Cumulative Savings	6.59	36.5%
London Plan Target Savings	6.32	35%
Annual Surplus	0.27	
Camden CPG3 Target by renewables	2.90	20% of energy consumption by renewables
Element of energy consumption by renewables	3.04 (of 14.51)	20.9%

Please refer to Appendix 1 of this report for tabulated SAP outputs for each apartment. Due to the massive range of different apartment layouts there are no 'typical' layouts so SAP modelling has been carried out for each individual apartment type, and there are numerous. Added to this there are two models for each type, a Part L compliant version and also a variant that adds communal heating and renewables. Full SAP outputs are available on request and will take a week to generate.

4.16 Unregulated Loads

Unregulated loads consist of appliance use and kitchen use and are assessed using BRE Domestic Energy Modelling (BREDEM) methodology. The follow calculations are based on electric appliance and electric cooking loads.

Plot 2

	TonnesCO2/year
Appliances	37.22
Cooking	7.25

Plot 5

	TonnesCO2/year
Appliances	21.40
Cooking	4.14

Plot 6

	TonnesCO2/year
Appliances	15.74
Cooking	2.95

5.0 APPENDIX 1 – TABULATED SAP OUTPUTS

Apartment	Apt Area, m2	TER Part L, kgCO2/m2.yr	TER TonneCO2/yr	DER kgCO2m2.yr Passive+MVHR (no DH)	DER TonneCO2/yr	TER London Plan, kgCO2/m2.yr	DER kgCO2m2.yr DH+MVHR	DER TonneCO2/yr DH+MVHR	CPG3 Target (20% renewables)	PV area added, m2	DER kgCO2/m2.yr DH+MVHR+PV	TonneCO2/yr DH+MVHR+PV	TFEE	DFEE
A01	90.5	14.31	1.30	15.17	1.37	9.30	12.67	1.15	10.14	4.7	9.2	0.83	36.8	34.7
A02	55.2	18.62	1.03	19.61	1.08	12.10	16.37	0.90	13.10	3.5	12.1	0.67	46.5	45.8
A03	82.5	16.56	1.37	16.27	1.34	10.76	13.46	1.11	10.77	3.3	10.75	0.89	45.7	42.5
A04	84.9	15.54	1.32	15.31	1.30	10.10	12.81	1.09	10.25	3.5	10.06	0.85	41.8	36.5
A05	55.9	16.06	0.90	15.75	0.88	10.44	13.45	0.75	10.76	2.5	10.4	0.58	33.3	31
A06	52.5	18.36	0.96	18.6	0.98	11.93	15.55	0.82	12.44	2.9	11.88	0.62	42.1	40.9
A07	90.8	14.98	1.36	14.78	1.34	9.74	12.46	1.13	9.97	3.7	9.7	0.88	39.8	33.2
A08	82.5	16.56	1.37	16.27	1.34	10.76	13.46	1.11	10.77	3.3	10.75	0.89	45.7	42.5
A09	84.9	15.54	1.32	15.31	1.30	10.10	12.81	1.09	10.25	3.5	10.06	0.85	41.8	36.5
A10	55.9	16.06	0.90	15.75	0.88	10.44	13.45	0.75	10.76	2.5	10.4	0.58	33.3	31
A11	52.5	18.36	0.96	18.6	0.98	11.93	15.55	0.82	12.44	2.9	11.88	0.62	42.1	40.9
A12	90.8	14.98	1.36	14.78	1.34	9.74	12.46	1.13	9.97	3.7	9.7	0.88	39.8	33.2
A13	82.5	16.56	1.37	16.27	1.34	10.76	13.46	1.11	10.77	3.3	10.75	0.89	45.7	42.5
A14	84.9	15.54	1.32	15.31	1.30	10.10	12.81	1.09	10.25	3.5	10.06	0.85	41.8	36.5
A15	55.9	16.06	0.90	15.75	0.88	10.44	13.45	0.75	10.76	2.5	10.4	0.58	33.3	31
A16	52.5	18.36	0.96	18.6	0.98	11.93	15.55	0.82	12.44	2.9	11.88	0.62	42.1	40.9
A17	90.8	14.98	1.36	14.78	1.34	9.74	12.46	1.13	9.97	3.7	9.7	0.88	39.8	33.2
A18	82.5	16.56	1.37	16.27	1.34	10.76	13.46	1.11	10.77	3.3	10.75	0.89	45.7	42.5
A19	84.9	15.54	1.32	15.31	1.30	10.10	12.81	1.09	10.25	3.5	10.06	0.85	41.8	36.5
A20	55.9	16.06	0.90	15.75	0.88	10.44	13.45	0.75	10.76	2.5	10.4	0.58	33.3	31
A21	52.5	18.36	0.96	18.6	0.98	11.93	15.55	0.82	12.44	2.9	11.88	0.62	42.1	40.9
A22	90.8	14.98	1.36	14.78	1.34	9.74	12.46	1.13	9.97	3.7	9.7	0.88	39.8	33.2
A23	83.9	16.56	1.39	16.27	1.37	10.76	15.3	1.28	12.24	4.6	11.62	0.97	52.7	47.3
A24	84.9	15.54	1.32	15.31	1.30	10.10	12.81	1.09	10.25	3.5	10.06	0.85	41.8	36.5
A25	55.9	16.06	0.90	15.75	0.88	10.44	13.45	0.75	10.76	2.5	10.4	0.58	33.3	31
A26	52.5	18.36	0.96	18.6	0.98	11.93	15.55	0.82	12.44	2.9	11.88	0.62	42.1	40.9
A27	85	15.22	1.29	14.94	1.27	9.89	12.48	1.06	9.98	3.3	9.89	0.84	40.4	36.8
A28	86.5	14.97	1.29	14.77	1.28	9.73	12.49	1.08	9.99	3.6	9.69	0.84	39.5	31.6
A29	55.9	16.06	0.90	15.75	0.88	10.44	13.45	0.75	10.76	2.5	10.4	0.58	33.3	31
A30	52.4	16.4	0.86	16.11	0.84	10.66	13.85	0.73	11.08	2.5	10.6	0.56	33.1	28.3
A31	86.5	14.97	1.29	14.77	1.28	9.73	12.49	1.08	9.99	3.6	9.69	0.84	39.5	31.6
A32	55.9	16.06	0.90	15.75	0.88	10.44	13.45	0.75	10.76	2.5	10.4	0.58	33.3	31
A33	52.4	16.4	0.86	16.11	0.84	10.66	13.85	0.73	11.08	2.5	10.6	0.56	33.1	28.3
A34	102.4	17.37	1.78	18.07	1.85	11.29	15.06	1.54	12.05	6.1	11.04	1.13	54	49.8
A35	101.5	14.98	1.52	15.65	1.59	9.74	13.21	1.34	10.57	5.3	9.72	0.99	43.7	40.1
	2567.8		**41.22**		**41.05**			**34.64**		**117.4**		**26.75**		

Apartment	Apt Area, m2	TER Part L, kgCO2/m2.yr	TER TonneCO2/yr	DER kgCO2m2.yr Passive+MVHR (no DH)	DER TonneCO2/yr	TER London Plan, kgCO2/m2.yr	DER kgCO2m2.yr DH+MVHR	DER TonneCO2/yr DH+MVHR	CPG3 Target (20% renewables)	PV area added, m2	DER kgCO2/m2.yr DH+MVHR+PV	TonneCO2/yr DH+MVHR+PV	TFEE	DFEE
B01	119	16.79	2.00	17.49	2.08	10.91	14.45	1.72	11.56	6.7	10.68	1.27	59.7	55.1
B02	60.7	17.03	1.03	16.87	1.02	11.07	13.74	0.83	10.99	2.6	10.86	0.66	39	32.4
B03	85.8	16.16	1.39	16.32	1.40	10.50	13.34	1.14	10.67	3.7	10.47	0.90	44.7	37.3
B04	112.7	14.22	1.60	14.05	1.58	9.24	11.65	1.31	9.32	4.1	9.23	1.04	41.5	33.3
B05	84.8	15.52	1.32	15.51	1.32	10.09	12.66	1.07	10.13	3.3	10.07	0.85	40.9	33.4
B06	85.8	16.16	1.39	16.32	1.40	10.50	13.34	1.14	10.67	3.7	10.47	0.90	44.7	37.3
B07	81.3	16.08	1.31	16.73	1.36	10.45	13.75	1.12	11.00	4.0	10.44	0.85	42.8	36.1
B08	57	16.67	0.95	17.35	0.99	10.84	14.2	0.81	11.36	2.9	10.82	0.62	36.5	33.7
B09	53.5	17.43	0.93	16.96	0.91	11.33	13.8	0.74	11.04	2.0	11.28	0.60	38.5	33
B10	84.8	16.85	1.4	17.8	1.51	10.95	14.52	1.23	11.62	4.7	10.82	0.92	47.7	44
B11	85.8	17.87	1.53	18.92	1.62	11.62	15.46	1.33	12.37	4.9	11.59	0.99	53.4	48.7
B12	81.3	16.08	1.31	16.73	1.36	10.45	13.75	1.12	11	4	10.44	0.85	42.8	36.1
B13	57	16.67	0.95	17.35	0.99	10.84	14.20	0.81	11.36	2.87	10.82	0.62	36.5	33.7
B14	53.5	17.43	0.93	16.96	0.91	11.33	13.80	0.74	11.04	2.00	11.28	0.60	38.5	33.0
B15	81.3	16.08	1.31	16.73	1.36	10.45	13.75	1.12	11.00	4.00	10.44	0.85	42.8	36.1
B16	57	16.67	0.95	17.35	0.99	10.84	14.20	0.81	11.36	2.87	10.82	0.62	36.5	33.7
B17	53.5	17.43	0.93	16.96	0.91	11.33	13.80	0.74	11.04	2.00	11.28	0.60	38.5	33.0
B18	81.3	17.76	1.44	19.29	1.57	11.54	15.83	1.29	12.66	5.2	11.53	0.94	51.4	47.5
B19	57	18.31	1.04	19.19	1.09	11.90	15.7	0.89	12.56	3.27	11.85	0.68	45	42.5
B20	53.5	19.11	1.02	19.32	1.03	12.42	15.96	0.85	12.77	2.60	12.43	0.67	47.2	44.2
	1486.6		**24.77**		**25.40**			**20.82**		**71.20**		**16.02**		

Apartment	Apt Area, m2	TER Part L, kgCO2/m2.yr	TER TonneCO2/yr	DER kgCO2m2.yr Passive+MVHR (no DH)	DER TonneCO2/yr	TER London Plan, kgCO2/m2.yr	DER kgCO2m2.yr DH+MVHR	DER TonneCO2/yr DH+MVHR	CPG3 Target (20% renewables)	PV area added, m2	DER kgCO2/m2.yr DH+MVHR+PV	DER TonneCO2/yr DH+MVHR+PV	TFEE	DFEE
C01	50.1	17.26	0.86	16.76	0.84	11.22	13.68	0.69	10.94	1.87	11.18	0.56	35.4	31.9
C02	88.3	15.76	1.39	15.81	1.40	10.24	12.99	1.15	10.39	3.93	10.00	0.88	41.9	37.7
C03	64.5	18.48	1.19	18.71	1.21	12.01	15.34	0.99	12.27	3.4	11.8	0.76	47.7	42.6
C04	60.1	16.94	1.02	17	1.02	11.01	13.97	0.84	11.18	2.73	10.91	0.66	39.3	36
C05	94.3	15.39	1.45	14.47	1.36	10.00	11.86	1.12	9.49	3	9.72	0.92	41.2	32.9
C06	80	16.91	1.35	16.24	1.30	10.99	13.26	1.06	10.61	3.07	10.68	0.85	44.6	38.3
C07	85.3	14.44	1.23	13.93	1.19	9.39	11.44	0.98	9.15	3	9.08	0.77	34.8	27.7
C08	60.1	16.94	1.02	17.00	1.02	11.01	13.97	0.84	11.18	2.73	10.91	0.66	39.30	36.00
C09	94.3	15.39	1.45	14.47	1.36	10.00	11.86	1.12	9.49	3.00	9.72	0.92	41.20	32.90
C10	80	16.91	1.35	16.24	1.30	10.99	13.26	1.06	10.61	3.07	10.68	0.85	44.60	38.30
C11	85.3	16.02	1.37	15.6	1.33	10.41	12.76	1.09	10.21	3.33	10.13	0.86	42.8	38.2
C12	77.2	16.65	1.29	16.38	1.26	10.82	13.34	1.03	10.67	3.33	10.44	0.81	44.6	39.8
C13	94.3	17.33	1.63	17.18	1.62	11.26	14.02	1.32	11.22	4.33	10.93	1.03	51	45
C14	80	18.19	1.46	18.93	1.51	11.82	15.47	1.24	12.38	4.40	11.78	0.94		
	1093.8		**18.07**		**17.73**	**151.20**		**14.51**	**149.78**	**45.20**	**147.96**	**11.48**		