AJ ENERGY CONSULTANTS LIMITED

22 Kings Mews, London

Energy Strategy

September 2014

CUTTING THE COST OF CARBON

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1 Issue Register

Revision	Reason for Issue	Date of Issue	Issued By
1.0	For comment	31/10/12	J Simpson CEng MCIBSE
2.0	Updated following comments	06/11/12	J Simpson CEng MCIBSE
3.0	Project title updated	19/11/12	J Simpson CEng MCIBSE
4.0	Updated following scheme revisions	04/09/14	J Simpson CEng MCIBSE

2 Contents

3 Executive Summary

This document responds to planning policy in respect of energy consumption and carbon dioxide emissions. The methodology used herein is consistent with the London Renewables Toolkit (LRT) and Part L of the Building Regulations.

The Proposed Development features improved insulation and air tightness standards, when compared against the compliance requirements of Part L 2013 of the Building Regulations. In addition, energy efficient lighting is to be provided throughout the dwellings in excess of the Part L1 2013 requirements.

There are no details of installed district heating schemes in the immediate vicinity of the site, and the Proposed Development is considered to be too small to successfully incorporate a community heating system. It is also considered that the small increase in heating plant efficiency due to the incorporation of a system would be cancelled out by the increase in energy consumption required to pump the heating water circuit.

Combined heat and power (CHP) has been assessed in terms of feasibility. There is no economic or sustainable justification for over-sizing the CHP plant, and therefore the CHP unit size needs to be carefully matched to the demands of the development. The smallest commercially available CHP unit is too large for the scheme due to the limited number of residential dwellings and the small hot water demand of the commercial unit, and therefore CHP is not considered to be viable for the Proposed Development.

A feasibility study of the currently available low and zero carbon technologies has been undertaken, with photovoltaic panels proposed for the development at roof level, to generate electricity for the site. It has been estimated that the proposed photovoltaic systems would reduce the annual carbon dioxide emissions of the site by 989 $kgCO_2$, which equates to a reduction of 30.4%.

The incorporation of the energy efficiency measures and photovoltaic panels equates to a minimum reduction of 37.4% against the TER 2013 for the scheme, which exceeds the 35% improvement requirement under the London Plan 2011, as noted by the GLA guidance on energy assessments using 2013 Building Regulations compliant calculations.

A summary of the reduction in emissions is shown in Tables 1 and 2 below, and graphically in Figure 1 below.

Stage	Regulated carbon dioxide emissions (heating, hot water, lighting, fans & pumps)	Unregulated carbon dioxide emissions (unregulated includes cooking, appliances, communal lighting & power)
Building Regulations Compliance (TER 2013)	3,608 $kgCO_2$/annum	2,531 $kgCO_2$/annum
Energy Efficiency Measures ('Be Lean')	3,248 $kgCO_2$/annum	2,531 $kgCO_2$/annum
Proposed Development ('Be Clean')	2,260 $kgCO_2$/annum	2,531 $kgCO_2$/annum
Proposed Development with PVs ('Be Green')	2,260 $kgCO_2$/annum	2,531 $kgCO_2$/annum

Table 1 – Summary of carbon dioxide emissions for each carbon reduction stage

Stage	Regulated carbon dioxide savings	
	(kgCO2 per annum)	(%)
Savings from energy demand reduction	360	10
Savings from CHP	-	-
Savings from renewable energy	989	30.4
Total Cumulative Savings	**1,349**	**37.4**

Table 2 – Summary of carbon dioxide savings for each carbon reduction stage

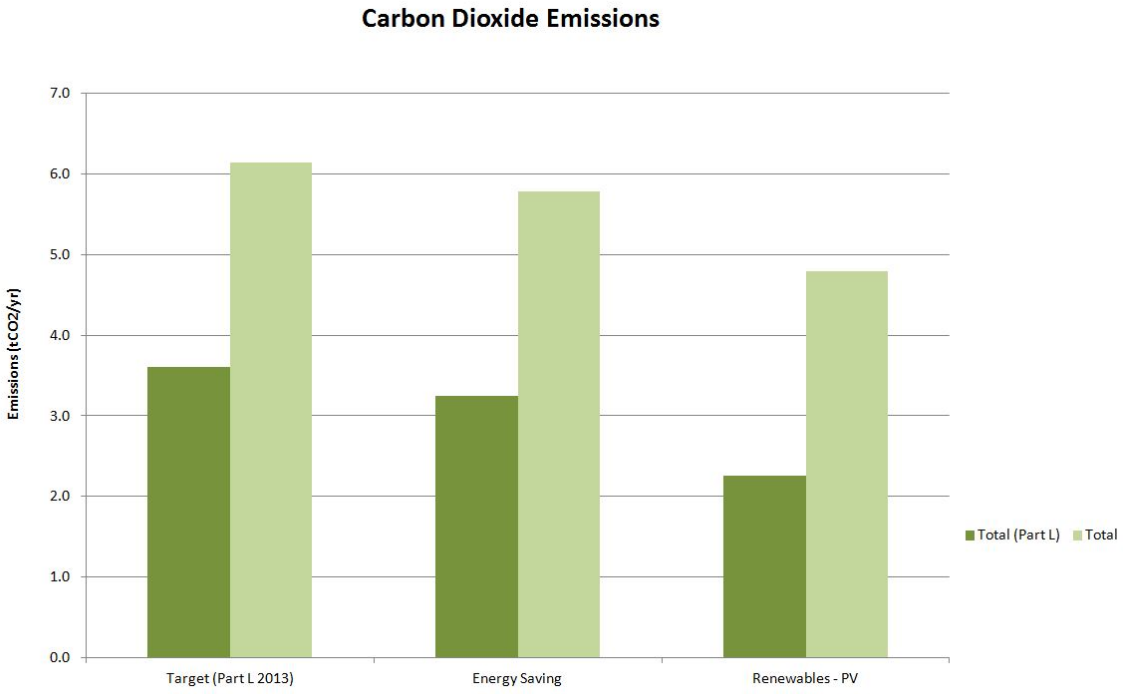

Figure 1 – Summary of carbon dioxide emissions

4 Introduction

4.1 Proposed Development

The Proposed Development comprises the construction of a new build four storey townhouse on King Mews, London. The project comprises the retention of the existing building facade.

4.2 Planning Policy Context

4.2.1 National

The following description is taken from the LRT

"Increased development of renewable energy resources is vital to facilitating the delivery of the Government's commitments on both climate change and renewable energy. The Government's Energy Policy, including its policy on renewable energy, is set out in the Energy White Paper. This aims to put the UK on a path to cut its carbon dioxide emissions by some 60% by 2050, with real progress by 2020, and to maintain reliable and competitive energy supplies. As part of the strategy for achieving these reductions the White Paper sets out:

- The Government's target to generate 10% of UK electricity from renewable energy sources by 2010
- The Government's aspiration to double that figure to 20% by 2020 and suggests that still more renewable energy will be needed beyond that date.

"The Energy White Paper indicated that the Government would be looking to work with regional and local bodies to deliver its objectives, including establishing regional targets for renewable energy generation. Regional Planning Guidance should include the target for renewable energy generation for its respective region, derived from assessments of the region's renewable energy resource potential."

The *National Planning Policy Framework* sets out the Government's national policy for renewable energy. It states that "to help increase the use and supply of renewable and low carbon energy, local planning authorities should recognise the responsibility on all communities to contribute to energy generation from renewable or low carbon sources."

4.2.2 Regional

The London Plan is the overall strategic plan for London, and it sets out a fully integrated economic, environmental, transport and social framework for the development of the capital to 2031. It forms part of the development plan for Greater London. The London Plan 2011 was published on 22 July 2011.

Policy 5.2 (Minimising Carbon Dioxide Emissions) states that:

"Development proposals should make the fullest contribution to minimizing carbon dioxide emissions in accordance with the following energy hierarchy:

1 – Be lean: use less energy
2 – Be clean: supply energy efficiently

3 – Be green: use renewable energy

The Mayor will work with boroughs and developers to ensure that major developments meet the following targets for carbon dioxide emissions reduction in buildings. These targets are expressed as minimum improvements over the Target Emission Rate (TER) outlined in the national Building Regulations leading to zero carbon residential buildings from 2016 and zero carbon non-domestic buildings from 2019.

Year	Improvement on 2010 Building Regulations	
	Residential buildings	**Non-domestic buildings**
2010 – 2013	25 per cent	25 per cent
2013 – 2016	40 per cent	40 per cent
2016 – 2019	Zero carbon	As per building regulations requirements
2019 – 2031		Zero carbon

Table 3 – Proposed carbon dioxide reduction targets under the 2011 London Plan

Major development proposals should include a detailed energy assessment to demonstrate how the targets for carbon dioxide emissions reduction outlined above are to be met within the framework of the energy hierarchy.

As a minimum, energy assessments should include the following:

a) Calculation of the energy demand and carbon dioxide emissions covered by the Building Regulations and, separately, the energy demand and carbon dioxide emissions from any other part of the development, including plant or equipment, that are not covered by the Building Regulations at each stage of the energy hierarchy
b) Proposals to reduce carbon dioxide emissions through the energy efficient design of the site, buildings and services
c) Proposals to further reduce carbon dioxide emissions through the use of decentralized energy where feasible, such as district heating and cooling and combined heat and power (CHP)
d) Proposals to further reduce carbon dioxide emissions through the use of on-site renewable energy technologies."

Policy 5.7 (Renewable Energy) states that:

"The Mayor seeks to increase the proportion of energy generated from renewable sources, and expects that the projections for installed renewable energy capacity outlined in the Climate Change Mitigation and Energy Strategy and in supplementary planning guidance will be achieved in London.

Within the framework of the energy hierarchy, major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible."

4.2.3 Local

The Core Strategy was adopted by the London Borough of Camden on 8 November 2010, and sets out the key vision for the borough up to 2025.

Policy CS13 states that:

"**Reducing the effects of and adapting to climate change**

The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by:

a) ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;
b) promoting the efficient use of land and buildings
c) minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:
   1. ensuring developments use less energy,
   2. making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralized energy networks;
   3. generating renewable energy on-site;
   and
d) ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

The Council will have regard to the cost of installing measures to tackle climate change as well as the cumulative future costs of delaying reductions in carbon dioxide emissions.

Local energy generation

The Council will promote local energy generation and networks by:

e) working with our partners and developers to implement local energy networks in the parts of Camden most likely to support them, i.e. in the vicinity of:
   – housing estates with community heating or the potential for community heating and other uses with large heating loads;
   – the growth areas of King's Cross; Euston; Tottenham Court Road; West Hampstead Interchange and Holborn;
   – schools to be redeveloped as part of Building Schools for the Future programme;
   – existing or approved combined heat and power/local energy networks (see Map 4);

   and other locations where land ownership would facilitate their implementation.
f) protecting existing local energy networks where possible (e.g. at Gower Street and Bloomsbury) and safeguarding potential network routes (e.g. Euston Road)."

Development Policy DP22 on 'Promoting sustainable design and construction' states that:

"The Council will require development to incorporate sustainable design and construction measures. Schemes must:

a) demonstrate how sustainable development principles, including the relevant measures set out in paragraph 22.5 below, have been incorporated into the design and proposed implementation; and
b) incorporate green or brown roofs and green walls wherever suitable.

The Council will promote and measure sustainable design and construction by:

c) 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.;
d) expecting developments (except new build) of 500 sq m of residential floorspace or above or 5 or more dwellings to achieve "very good" in EcoHomes assessments prior to 2013 and encouraging "excellent" from 2013;
e) expecting non-domestic developments of 500sqm of floorspace or above to achieve "very good" in BREEAM assessments and "excellent" from 2016 and encouraging zero carbon from 2019.

The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:

f) summer shading and planting;
g) limiting run-off;
h) reducing water consumption;
i) reducing air pollution; and
j) not locating vulnerable uses in basements in flood-prone areas."

5 Methodology

This report draws on the information and approach set out in the LRT. The currency used for emissions is carbon dioxide, rather than the carbon equivalent, for consistency with Part L of the Building Regulations.

A Part L analysis is conducted to calculate carbon dioxide emissions for the following end uses: heating; hot water; cooling; fans, pumps and controls; and lighting. Various energy-saving measures are considered in terms of technical and economic feasibility and their effect on carbon dioxide emissions. A package of energy-saving measures is proposed that meets the Part L standard, without reliance on the contribution of CHP or renewables. Unregulated energy end uses, such as appliances, are added using the SBEM or SAP software.

CHP is then considered in terms of technical and economic feasibility and its effect on carbon dioxide emissions. The strategic issues relating to each technology are also considered in the context of the Proposed Development, and two or three preferred options are short-listed. These are then considered in more detail in terms of technical and economic feasibility and its effect on carbon dioxide emissions.

Calculations are presented in summary form in subsequent sections, with detailed calculations in Appendix A.

Figure 2 below provides a summary of the methodology in the form of a flow diagram.

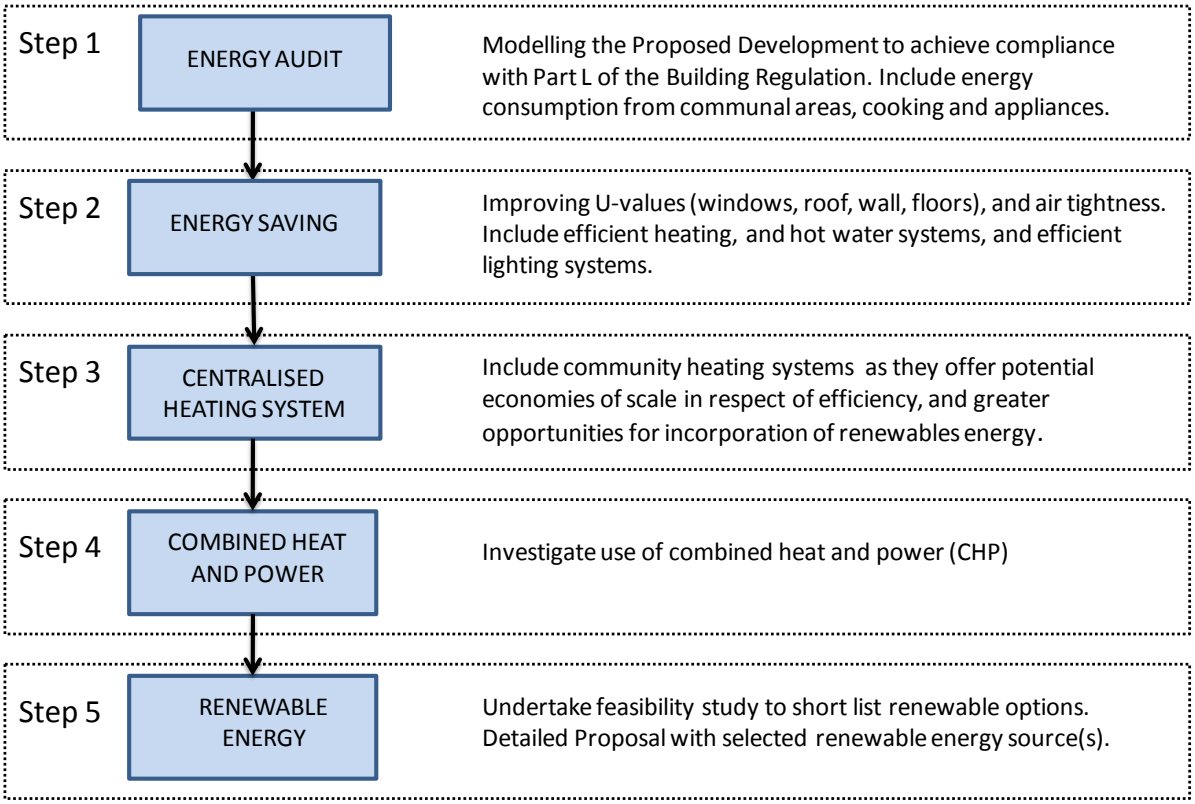

Figure 2 – Flow diagram of methodology

6 Energy Demand

The Development would feature energy saving measures such that compliance with Part L of the Building Regulations (2013) would be achieved without reliance on the contribution of renewable technologies.

6.1 Residential

As required under Part L, the new build residential units have been assessed under Part L1A 2013, with calculations undertaken using the Stroma FSAP 2012 software to establish the energy consumption of the scheme.

The minimum requirements for compliance with Part L1A were established, and feasible improvements were included to further reduce the carbon dioxide emissions. The measures outlined below have been used in the Part L1A calculations, and exceed the requirements of Part L1A. The proposed fabric performance is compared against the Part L1A 2013 requirements in Table 4 below:

Element	Proposed Development	Part L1A 2013 Requirements
External wall U-value	0.24 W/m².K	0.30 W/m².K
Exposed roof U-value	0.15 W/m².K	0.20 W/m².K
Exposed floor U-value	0.10 W/m².K	0.25 W/m².K
Window U-value	1.40 W/m².K	2.00 W/m².K
Party wall U-value	0.00 W/m².K (fully filled party wall)	0.20 W/m².K
Air permeability	3 m³/hr/m² @ 50 Pa (with tests undertaken in each dwelling)	10 m³/hr/m² @ 50 Pa
Thermal bridging	Accredited Construction Details to be used	0.15
Low energy lighting	100%	75%

Table 4 – Comparison of proposed residential fabric performance for new build dwellings

A high efficiency gas-fired boiler is proposed for the dwelling in order to provide a system with low running costs. It is also proposed that time and temperature zone control and weather compensation is provided for the dwelling.

A whole house ventilation system with heat recovery has been modelled within the energy calculations. The use of this system would improve the air tightness of the scheme from the omission of trickle vents, and would also reduce heating requirements and energy running costs.

7 Community Heating & CHP

The Mayor's Energy Strategy favours community heating systems because they offer:

- Potential economies of scale in respect of efficiency and therefore reduced carbon emissions; and
- Greater potential for future replacement with Low or Zero Carbon (LZC) technologies.

There are no existing district heating systems in the immediate vicinity of the site, and therefore not considered to be feasible to connect to a district heating system. The Proposed Development is considered to be too small to successfully incorporate a community heating system, with typically 60 dwellings being the minimum to provide an economically feasible centralized system which also provides a reduction in carbon dioxide emissions. It is also considered that the small increase in heating plant efficiency due to the incorporation of a system of the limited size that this particular scheme would require would be cancelled out by the increase in energy consumption required to pump the heating water circuit.

Combined heat and power (CHP) has been assessed in terms of feasibility. There is no economic or sustainable justification for over-sizing the CHP plant, and therefore the CHP unit size needs to be carefully matched to the demands of the development. The Proposed Development is not large enough to contain a district wide CHP system to serve surrounding buildings and future schemes, and the smallest commercially available CHP unit is too large for the scheme due to the limited number of residential dwellings. CHP systems are usually specified for large schemes with more than 100-150 dwellings due to the need to have a large enough heat demand to supply from the CHP system – the smallest commercially available CHP unit (the Baxi DACHS micro-CHP unit) would supply 60 dwellings, and therefore would not be economically or technically feasible for this scheme. Therefore CHP is not considered to be viable for the Proposed Development.

8 Renewables – Feasibility Study

The LRT provides benchmark sizing and cost data for "renewable energy technologies suitable for London". It therefore provides information to assess the various technologies at an early design stage, with initial measurements of the impact of using each technology on the building's carbon dioxide emissions. Table 5 (below) outlines these technologies and the variations proposed in the LRT used in this assessment.

Technology	End Use Demand Met
Wind	Electricity
PV Cells - rooftop	Electricity
PV Cells - cladding	Electricity
Solar Water Heating	Annual DHW (50 %)
Biomass heating (a)	Annual Space Heating +Domestic Hot Water (33%)
Biomass heating (b)	Annual Space Heating +Domestic Hot Water (50%)
Biomass heating (c)	Annual Space Heating +Domestic Hot Water (100%)
Biomass CHP (a)	Annual Space Heating +Domestic Hot Water (33%)
Biomass CHP (b)	Annual Space Heating +Domestic Hot Water (50%)
Ground sourced heat pumps (a)	Annual Space Heating +Domestic Hot Water (50%)
Ground sourced heat pumps (b)	Annual Space Heating +Domestic Hot Water (100%)
Ground sourced heat pumps (c)	Peak Space Heating (50 %) Annual Space Heating + Domestic Hot Water (85 %)
Ground cooling (a)	Annual Cooling (50%)
Ground cooling (b)	Annual Cooling (100%)

Table 5 – Renewable energy technologies suitable for London

The following other "acceptable renewable energy technologies" are considered to be not typically appropriate in London:

- Fuel cells using hydrogen from renewable sources;
- Gas from anaerobic digestion;
- Geothermal;
- Ground cooling air systems;
- Micro hydro; and
- Solar air collectors.

On the basis of this preliminary analysis, and a review of the general advantages and disadvantages of the different technologies relative to the Proposed Development, the following technologies were not considered to be appropriate to the Proposed Development:

- **Wind turbines:** on the basis of visual appearance, noise issues and concerns over outputs in urban areas. Wind turbines are not considered appropriate for the urban context. There are still concerns over noise with the horizontal axis turbines, and therefore they are not considered appropriate for the development. The average wind speed for the Proposed Development is noted on the Encraft website as 4.7m/s at 10m – this is significantly below the required average wind speed to make wind turbines a practical solution, particularly when the power output of the turbines is reduced by 7/8ths when the wind speed is halved;

- **Biomass:** on the basis of concerns over air quality issues from flue discharge; concerns over transport issues relating to regular deliveries of biomass; security and cost of fuel supply; concerns over disposal of ash; and relatively high maintenance. Biomass is not considered to be a suitable fuel for use within an urban development, and therefore this technology is not considered appropriate for the development. Deliveries of biomass pellets is undertaken by large vehicles the equivalent size of domestic oil delivery tankers and it is not considered appropriate to have vehicles of this size navigating the local streets and making regular deliveries to the site;

- **Biomass CHP:** on the basis of embodied impacts; high maintenance; concerns over air quality issues from flue discharge; concerns over transport issues relating to regular deliveries of biomass; lack of micro-scale units on the market to suit this scale of development; and it being an immature technology. Biomass is not considered to be a suitable fuel for use within an urban development, therefore this technology is not considered appropriate for the development. A large biomass fuelled CHP with heat output of 200 kW is available, but this is approximately 40 times larger than required for this scheme, particularly as the current biomass fuelled CHP units need to operate 24/7 – biomass CHP is therefore not considered to be feasible for this scheme;

- **Solar thermal:** due to changes in the Building Regulations calculations, the incorporation of photovoltaic panels provide a greater percentage reduction in carbon dioxide than a solar thermal system, and therefore the proposed strategy of photovoltaic panels is considered to be the most appropriate solution;

- **Photovoltaic Panels:** it has been calculated that the reduction in carbon dioxide emissions from the proposed photovoltaic panels would be suitable for the site scheme. This technology is therefore considered appropriate for the development; and

- **Ground source:** due to the limited site area at ground level, there is insufficient area available for horizontal loops. The use of open loop boreholes has been discounted as there is a risk of drilling and not finding a suitable aquifer. The use of closed loop boreholes has been discounted because there is insufficient site area to contain the required number. The resultant carbon footprint of the scheme with gas boilers and photovoltaic panels is significantly lower than that using ground source or air source heat pumps, and therefore the proposed strategy is considered to be the most appropriate solution.

9 Renewables - Detailed Proposal

On the basis of this preliminary analysis, and a review of the general advantages and disadvantages of the different technologies relative to the Proposed Development, the following technologies were considered to be appropriate to the Proposed Development:

- Photovoltaic panels.

9.1 Photovoltaic Panels

Photovoltaic panels extract the energy of the sun to generate electricity. It is proposed that photovoltaic panels be installed on the roof, to generate electricity for the development. These electrical generation systems would be connected to the National Grid so that any surplus electricity can be exported to the Grid, and would be eligible for the feed-in tariffs.

It is proposed that photovoltaic panels are installed at roof level, facing due South. It has been calculated that 10 panels sized 1640mm by 1000mm can be installed at roof level, to generate approximately 1,901 kWh of electricity per annum. The proposed panel locations are shown in Appendix B.

Figure 3 - Typical photovoltaic panel installations

The provision of the photovoltaic system would reduce the carbon emissions by 989 $kgCO_2$ per annum, which equates to a reduction of 30.4% across the site.

10 Conclusion

This document has responded to planning policy in respect of energy consumption and carbon dioxide emissions. The methodology used herein has been consistent with the LRT and Part L of the Building Regulations.

The Proposed Development features improved insulation and air tightness standards, when compared against the compliance requirements of Part L 2013 of the Building Regulations. In addition, energy efficient lighting is to be provided throughout the dwellings in excess of the Part L1 2013 requirements.

There are no details of installed district heating schemes in the immediate vicinity of the site, and the Proposed Development is considered to be too small to successfully incorporate a community heating system. It is also considered that the small increase in heating plant efficiency due to the incorporation of a system would be cancelled out by the increase in energy consumption required to pump the heating water circuit.

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A feasibility study of the currently available low and zero carbon technologies has been undertaken, with photovoltaic panels proposed for the development at roof level, to generate electricity for the site. It has been estimated that the proposed photovoltaic systems would reduce the annual carbon dioxide emissions of the site by 989 $kgCO_2$, which equates to a reduction of 30.4%.

The incorporation of the energy efficiency measures and photovoltaic panels equates to a minimum reduction of 37.4% against the TER 2013 for the scheme, which exceeds the 35% improvement requirement under the London Plan 2011, as noted by the GLA guidance on energy assessments using 2013 Building Regulations compliant calculations.

11 Appendix A – Detailed Calculations

See attached calculations.

Building Details

Building/Demise	Gross Internal Floor Area (m²)	Net Internal Floor Area (m²)	Sales Floor Area or Treated Floor Area (m²)	Relevant Floor Area for emissions (m²)	Relevant Floor Area for renewables (m²)	Relevant Floor Area for build cost (m²)	Benchmarked Build Cost (£)	Benchmarked Carbon Dioxide Emissions
New Build Residential	308	308	308	308	308	308	-	-

LRT Type (renewable energy benchmarks)	Infill medium density housing
LRT Type (delivered energy benchmarks)	Housing: Infill medium density housing

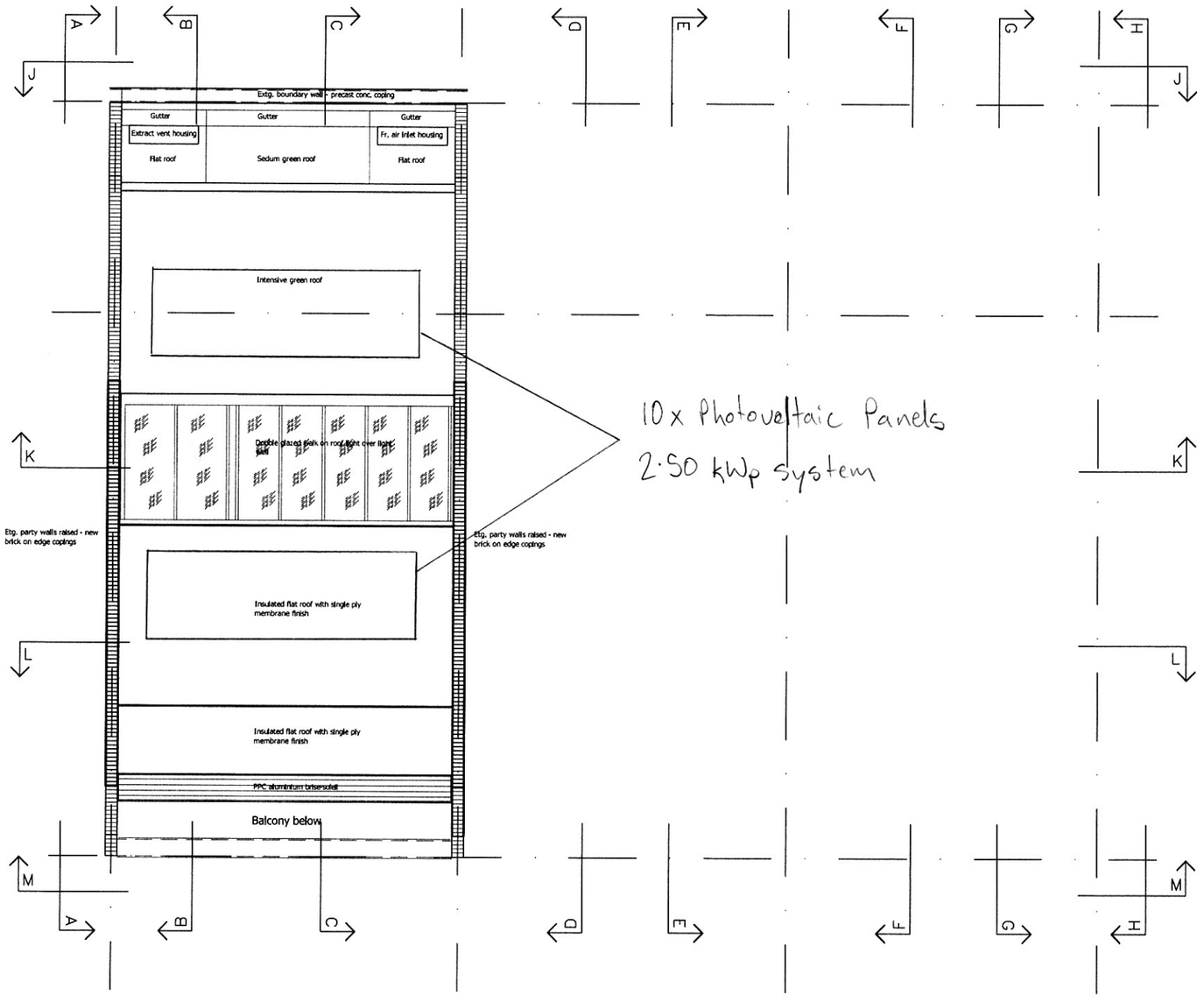
Carbon Dioxide Emissions

Key

Unknown
Calculated (SBEM)
Benchmark
Calculated (DesignBuilder)
Calculated (SAP 2012/NHER)
Calculated (other)

Model	Gas Demand (MWh)					Electricity Demand (MWh)								Carbon Dioxide Emissions (t)		
	Space heating	Hot water	Sub-total (Part L)	Other	Total	Space heating	Hot water	Cooling	Fans, pumps and controls	Lighting	Sub-total (Part L)	Other	Total	Elec. On-Site Generation	Total (Part L)	Total
Notional (Part L 2013)	11.6	2.8	14.3	0.0	14.3	0.0	0.0	0.0	0.1	0.8	0.9	4.9	5.8	0.0	3.6	6.1
Target (Part L 2013)														0.0	3.6	6.1
Energy Saving	7.1	2.8	9.9	0.0	9.9	0.0	0.0	0.0	1.2	0.8	2.0	4.9	6.9	0.0	3.2	5.8
Renewables - PV	7.1	2.8	9.9	0.0	9.9	0.0	0.0	0.0	1.2	0.8	2.0	4.9	6.9	1.0	2.3	4.8

12 Appendix B – Proposed PV Layout



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