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Energy Strategy

February 2012

CUTTING THE COST OF CARBON

www.ajenergy.com

1 Issue Register

Revision	Reason for Issue	Date of Issue	Issued By
1.0	For comment	31/10/11	J Simpson CEng MCIBSE
2.0	Updated following scheme revisions	14/02/12	J Simpson CEng MCIBSE

2 Contents

3 Executive Summary

This document responds to planning policy in respect of energy consumption and carbon dioxide (CO_2) 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 2010 of the Building Regulations.

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 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 commercial building and residential properties, and air source heat pumps for the residential properties. It has been estimated that the proposed photovoltaic and heat pump systems would reduce the annual carbon dioxide emissions of the site by 16,243 $kgCO_2$, which equates to a reduction of 24.7%.

The resultant carbon dioxide emissions, following the implementation of these measures, are 42.1% lower than Part L 2010 compliance, thereby exceeding the 25% improvement required under the London Plan 2011 and the Code Level 3 energy target under the Code for Sustainable Homes assessment.

A summary of the reduction in emissions is shown in Table 1 below, and graphically in Figure 1 below:

Stage	Regulated carbon dioxide emissions (heating, hot water, lighting, fans & pumps)	Regulated and unregulated carbon dioxide emissions (unregulated includes cooking, appliances, communal lighting & power)
Building Regulations Compliance (TER 2010)	45,104 $kgCO_2$/annum	68,533 $kgCO_2$/annum
Energy Efficiency Measures ('Be Lean')	42,345 $kgCO_2$/annum	65,774 $kgCO_2$/annum
Proposed Development with Heat Pumps ('Be Green')	32,274 $kgCO_2$/annum	55,703 $kgCO_2$/annum
Proposed Development with Photovoltaics ('Be Green')	26,102 $kgCO_2$/annum	49,531 $kgCO_2$/annum

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

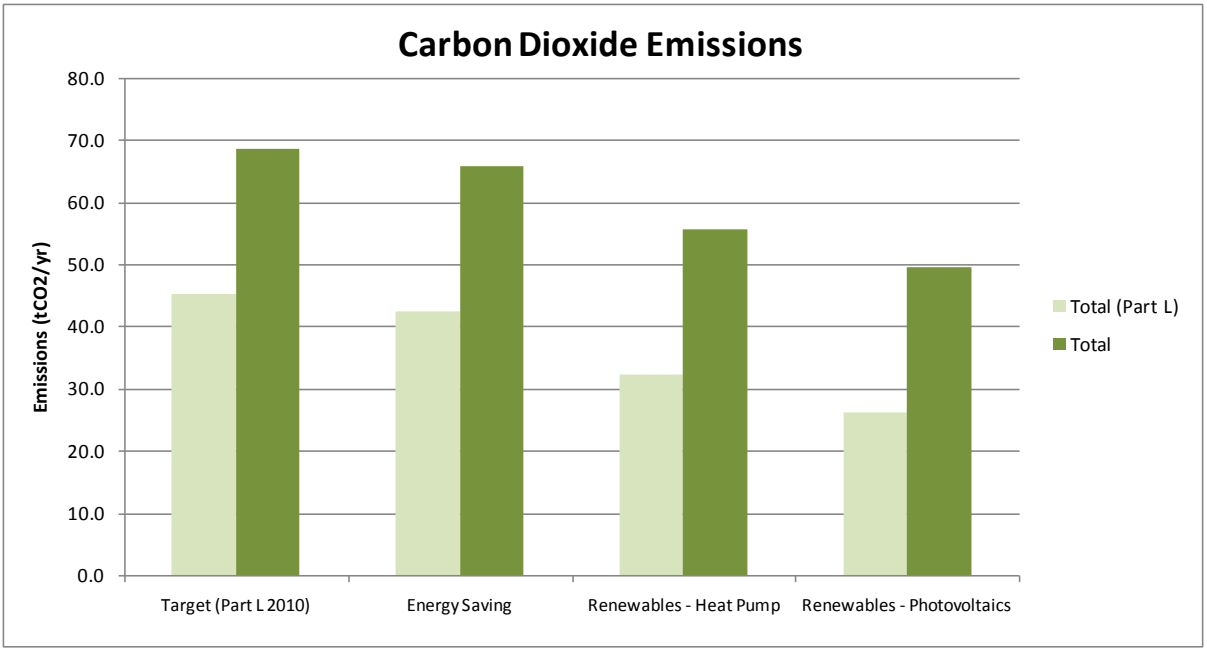

Figure 1 – Summary of carbon dioxide emissions

4 Introduction

4.1 Proposed Development

The Proposed Development consists of four new build 2-bedroom terrace houses and two 3-bedroom terrace houses, with a new build office building at the site entrance over four floors.

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."

Planning Policy Statement 22 (PPS 22) sets out the Government's national policy for renewable energy, in terms of both dedicated renewable generation projects (e.g. wind farms) and 'embedded' generation. It states that "local planning authorities may include policies in local development documents that require a percentage of the energy to be used in new residential, commercial or industrial developments to come from on-site renewable energy developments. Such policies:

(i) Should ensure that requirement to generate on-site renewable energy is only applied to developments where the installation of renewable energy generation equipment is viable given the type of development proposed, its location, and design;

(ii) Should not be framed in such a way as to place an undue burden on developers, for example, by specifying that all energy to be used in a development should come from on-site renewable generation.

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 2 – 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 and accompanying documents, as part of the Local Development Framework (LDF), were submitted in January 2010 for examination by an independent planning inspector. The Core Strategy and Development Policies were adopted at Full Council on the 8th November 2010.

It states within Section 3 of the Core Strategy that 'the Council will expect developments to achieve a reduction in carbon dioxide emission of 20 % from on-site renewable energy generation (which can include sources of site-related decentralised renewable energy) unless it can be demonstrated that such provision is not feasible.'

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. Additional non-regulated energy end uses such as cooking and appliances are also included. 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.

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.

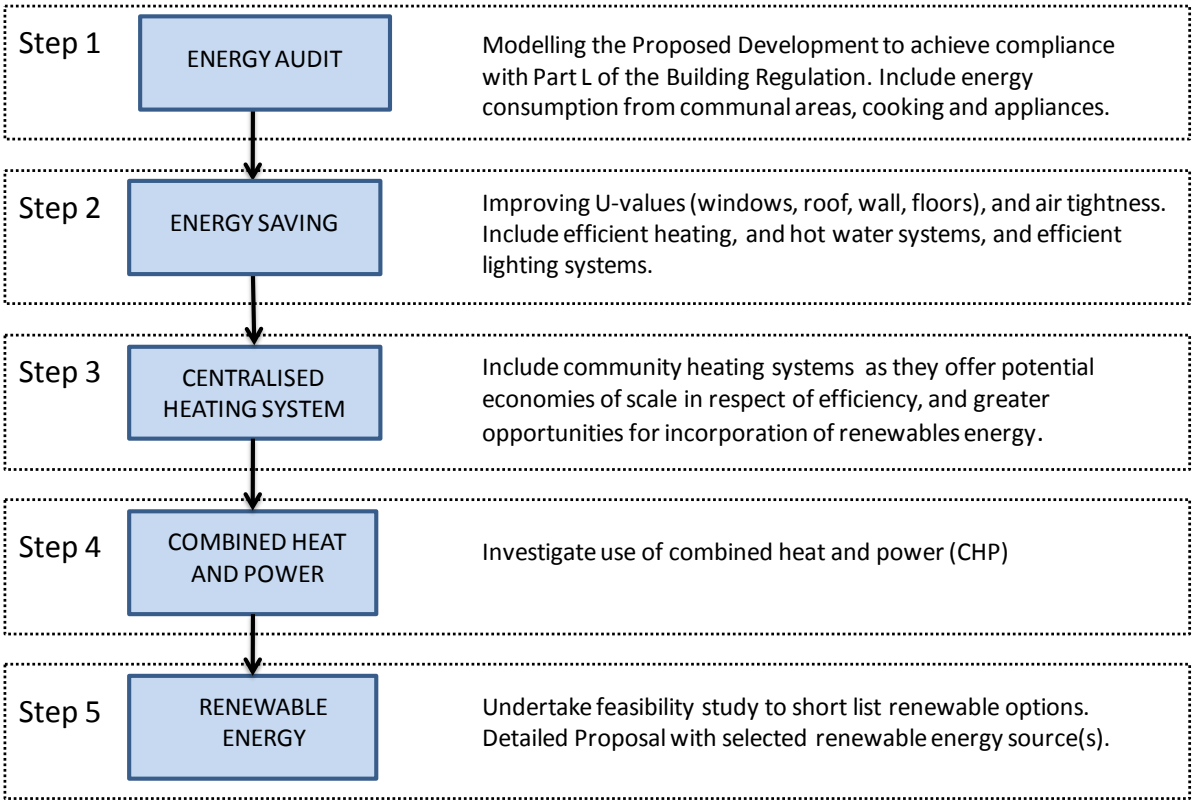

Figure 2 – Flow diagram of methodology

6 Energy Demand

The Development would feature energy saving measures to reduce the energy demands of the development. Details of these are noted below.

6.1 Residential

As required under Part L, the residential apartments have been assessed under Part L1A 2010, using accredited SAP 2009 software.

The minimum requirements for compliance with Part L1A were established, and feasible improvements were included to reduce the carbon dioxide emissions. The measures outlined below in Table 3 have been used in the Part L1A calculations, and exceed the requirements of Part L1A.

Element	Proposed Development	Part L1A 2010 Requirements
External wall U-value	0.25 W/m².K	0.30 W/m².K
Exposed roof U-value	0.18 W/m².K	0.20 W/m².K
Exposed floor U-value	0.18 W/m².K	0.25 W/m².K
Window & Door U-value	1.40 W/m².K	2.00 W/m².K
Party wall U-value	0.0 W/m².K	0.20 W/m².K
Air permeability	5 m³/hr/m² @ 50 Pa (with tests undertaken in each dwelling)	10 m³/hr/m² @ 50 Pa
Thermal bridging	0.08	0.15
Low energy lighting	100%	75%

Table 3 – Comparison of proposed residential performance

6.2 Commercial

As required under Part L, the commercial building has been assessed under Part L2A 2010, using accredited SBEM software.

The minimum requirements for compliance with Part L1A were established, and feasible improvements were included to reduce the carbon dioxide emissions. The measures outlined below in Table 3 have been used in the Part L1A calculations, and exceed the requirements of Part L1A.

Element	Proposed Development	Part L1A 2010 Requirements
External wall U-value	0.25 W/m².K	0.30 W/m².K
Exposed roof U-value	0.18 W/m².K	0.20 W/m².K
Exposed floor U-value	0.18 W/m².K	0.25 W/m².K

Window & Door U-value	1.40 W/m².K	2.00 W/m².K
Air permeability	5 m³/hr/m² @ 50 Pa	10 m³/hr/m² @ 50 Pa

Table 4 – Comparison of proposed commercial performance

In addition, energy efficient lighting with daylight and occupancy sensors is to be provided, with high efficiency gas heating system and local electric point-of-use water heaters.

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.

The Proposed Development is considered to be too small to successfully incorporate a community heating system, with typically 50 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 50 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 London Renewables Toolkit (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 4 (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 4 – 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;

- **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;

- **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, and therefore this technology is not considered appropriate for the development;

- **Solar thermal:** not considered feasible due to the large number of panels required for a development of this scale. Due to the revisions in the Part L Building Regulations compliance calculations the use of photovoltaic panels has a significantly higher reduction in carbon dioxide than solar thermal panels, and therefore solar thermal has not been specified; 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. Ground source is therefore not considered to be a viable option.

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 to generate electricity for the commercial building; and
- Air source heat pumps to generate space heating and domestic hot water for the residential dwellings.

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 of the building. 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 proposed by the Government.

Figure 3 - Typical photovoltaic panel installations

It is proposed that a total system of 9.4 kWp is installed at roof level on the commercial unit, with the panels angled at 30° from horizontal facing south-west. It has been estimated that the annual electricity production from the system would be 6,133 kWh. The photovoltaic system would be connected to the commercial building to generate electricity for use within the building. The proposed photovoltaic layout is shown on the roof plan attached in Appendix B. The layout is subject to change during the detailed design stage due to variations of panel size and outputs between manufacturers, and from product development.

In addition, individual photovoltaic systems of 1.5 kWp are proposed for each residential dwelling, with the panels angled at 5° from horizontal facing south-west. It has been estimated that the annual electricity production from these systems would be 5,535 kWh.

It has been estimated that the proposed photovoltaic systems would reduce the annual carbon dioxide emissions of the site by 6,172 kgCO_2.

9.2 Air Source Heat Pumps

It is proposed that individual air source heat pumps are installed within each residential dwelling. Hot water cylinders would be provided, with both space heating and domestic hot water provided by the heat pumps. Underfloor heating systems are proposed for each dwelling, as the lower water temperatures required for this type of heating system are more appropriate for heat pumps, and provide significantly higher efficiencies.

Plant space is provided with each rear garden to install any external condenser units for the heat pump systems. Screening is to be provided around the plant space, with acoustic louvres to be provided if required.

Figure 4 - Typical air source heat pump units

The provision of individual air source heat pumps would reduce the residential carbon emissions by 10,071 kgCO_2 per annum.

10 Conclusion

This document has responded to planning policy in respect of energy consumption and CO_2 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 2010 of the Building Regulations.

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 commercial building and residential properties, and air source heat pumps for the residential properties. It has been estimated that the proposed photovoltaic and heat pump systems would reduce the annual carbon dioxide emissions of the site by 16,243 $kgCO_2$, which equates to a reduction of 24.7%.

The resultant carbon dioxide emissions, following the implementation of these measures, are 42.1% lower than Part L 2010 compliance, thereby exceeding the 25% improvement required under the London Plan 2011 and the Code Level 3 energy target under the Code for Sustainable Homes assessment.

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
Residential	890	890	890	890	890	890	-	-

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 2009/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 2010)	103.5	33.5	137.0	0.0	137.0	9.1	0.0	0.0	1.5	5.0	15.6	14.1	29.7	0.0	35.2	42.5
Target (Part L 2010)														0.0	24.4	31.7
Energy-saving	82.8	26.8	109.6	0.0	109.6	0.0	0.0	0.0	0.0	2.9	2.9	14.1	17.0	0.0	23.2	30.5
Renewables - Heat Pump	0.0	0.0	0.0	0.0	0.0	14.8	7.7	0.0	0.0	2.9	25.4	14.1	39.5	0.0	13.1	20.4
Renewables - Photovoltaics	0.0	0.0	0.0	0.0	0.0	14.8	7.7	0.0	0.0	2.9	25.4	14.1	39.5	2.9	10.2	17.5
Proposed Development	0.0	0.0	0.0	0.0	0.0	14.8	7.7	0.0	0.0	2.9	25.4	14.1	39.5	2.9	10.2	17.5

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
Commercial Unit	737	737	737	737	737	737	-	-

LRT Type (renewable energy benchmarks)	Suburban standard office
LRT Type (delivered energy benchmarks)	Standard offices: Type 2

Carbon Dioxide Emissions

Key

Unknown
Calculated (SBEM)
Benchmark
Calculated (DesignBuilder)
Calculated (SAP 2009/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 2010)	-	-	-	-	-	-	-	-	-	-	-	31.2	-	0.0	31.9	45.1
Target (Part L 2010)														0.0	20.7	36.9
Energy-saving	27.4	0.0	27.4	0.0	27.4	0.0	3.4	0.0	2.6	20.6	26.5	31.2	57.7	0.0	19.1	35.3
Renewables - PV	27.4	0.0	27.4	0.0	27.4	0.0	3.4	0.0	2.6	20.6	26.5	31.2	57.7	3.2	15.9	32.0
Proposed Development	27.4	0.0	27.4	0.0	27.4	0.0	3.4	0.0	2.6	20.6	26.5	31.2	57.7	3.2	15.9	32.0

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
Site Total	1,627	1,627	1,627	1,627	1,627	1,627	-	-

LRT Type (renewable energy benchmarks)	
LRT Type (delivered energy benchmarks)	

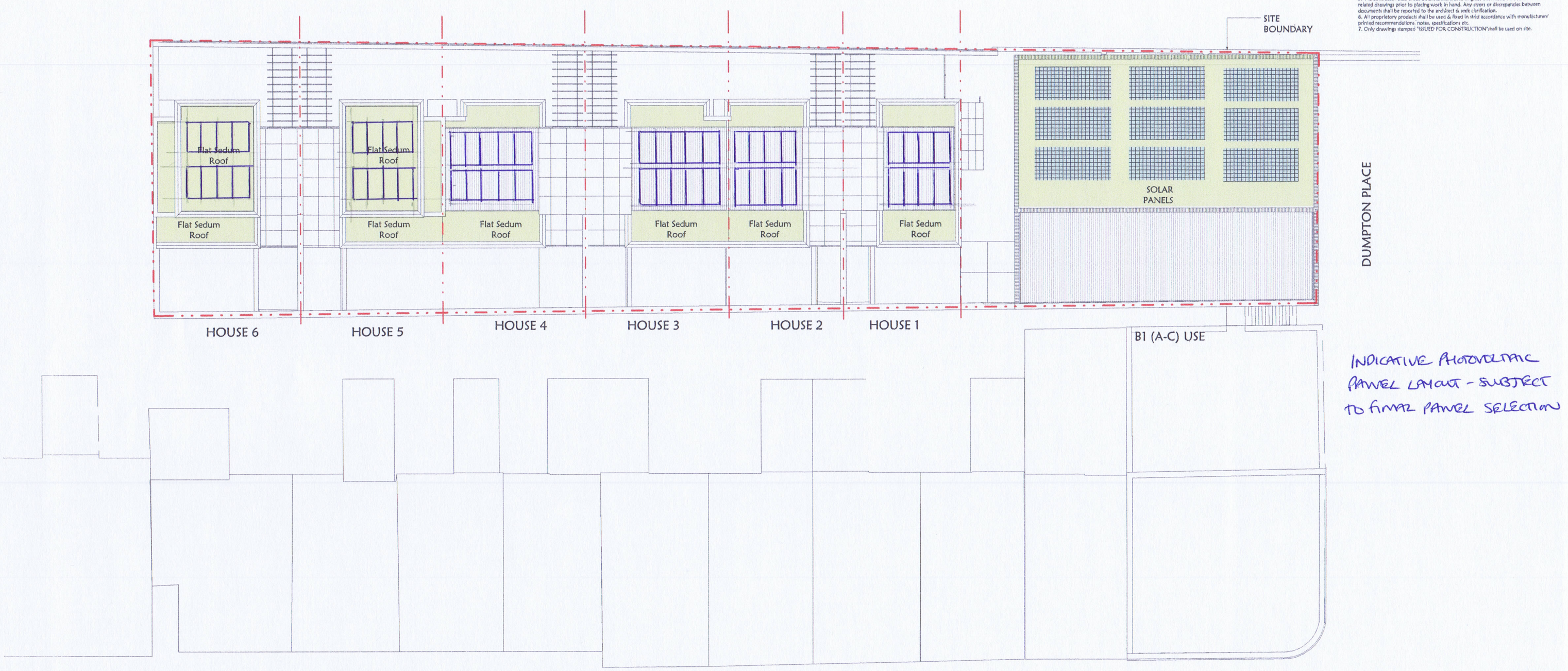
Carbon Dioxide Emissions

Key

Unknown
Calculated (SBEM)
Benchmark
Calculated (DesignBuilder)
Calculated (SAP 2009/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 2010)	-	-	-	-	-	-	-	-	-	-	-	45.3	-	0.0	54.0	74.6
Target (Part L 2010)														0.0	45.1	68.5
Energy Saving	110.2	26.8	137.0	0.0	137.0	0.0	3.4	0.0	2.6	23.5	29.4	45.3	74.8	0.0	42.3	65.8
Renewables - Heat Pump	27.4	0.0	27.4	0.0	27.4	14.8	11.0	0.0	2.6	23.5	51.9	45.3	97.2	0.0	32.3	55.7
Renewables - Photovoltaics	27.4	0.0	27.4	0.0	27.4	14.8	11.0	0.0	2.6	23.5	51.9	45.3	97.2	6.2	26.1	49.5

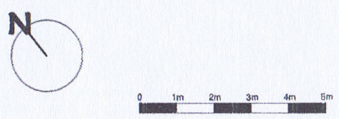
12 Appendix B – PV Roof Layout



INDICATIVE PHOTOVOLTAIC PANEL LAYOUT - SUBJECT TO FINAL PANEL SELECTION

PROPOSED ROOF PLAN

1 : 100



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Job Number: 01DP

Drawing Title

PROPOSED ROOF PLAN

Scale		Drawn By
1 : 100@A1		Author
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TOWN PLANNING

Drawing Status