LINTON HOUSE

ENERGY ASSESSMENT

Synergy Consulting Engineers Ltd
1 Canal Side Studios
8-14 St. Pancras Way
London
NW1 0QG

T: 0207 529 8950
F: 0207 388 1947
www.synconsult.co.uk

Contact Details

This report was prepared by:

Jim Grace
Synergy Consulting Engineers Ltd
1 Canal Side Studios
8-14 St Pancras Way
London
NW1 0QG

t: 0207 529 8950
d: 0207 529 8952
m: 07950 216 654
jim.grace@synconsult.co.uk

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1	28/01/2013	Draft
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CONTENTS

1.0 Executive Summary

This energy statement relates to a FULL planning submission.

The project involves the construction of a new residential extension on the roof of an existing office building on the Highgate Road, Camden. The proposed extension is single storey, approximately 950m2 and has 8No. Apartments.

The energy strategy is based on very high insulation levels, Air Souce Heat Pumps and roof-mounted Photovoltaic panels. The resulting regulated and unregulated emissions are sumarised below.

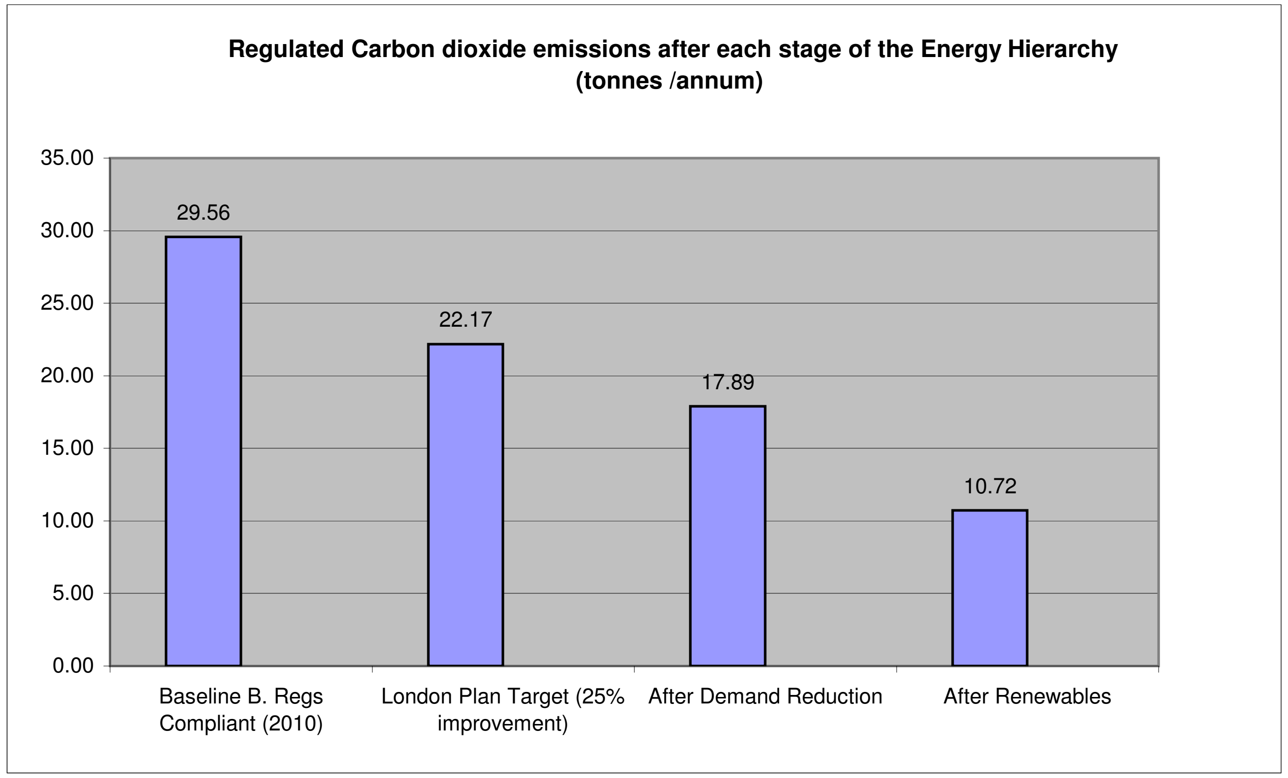


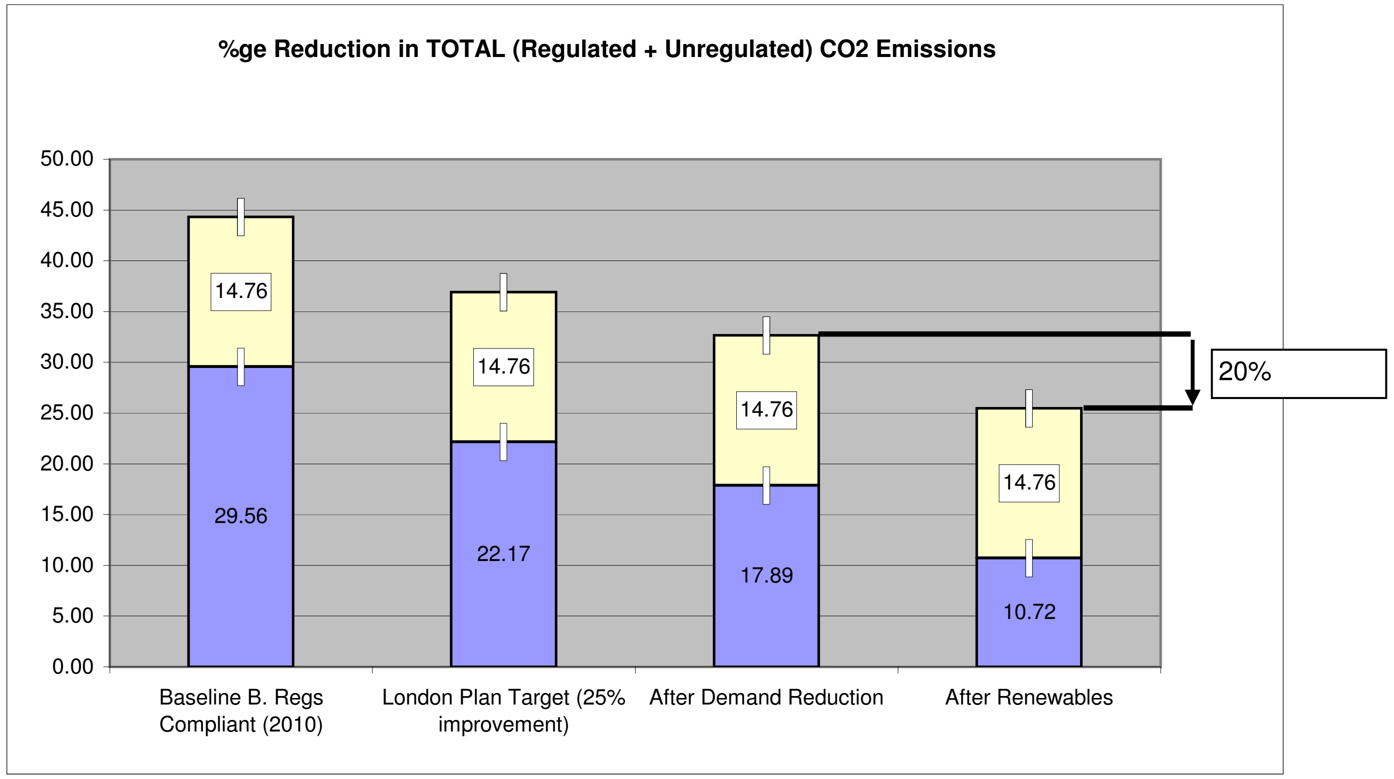
Table1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy

	Carbon dioxide emissions (Tonnes per annum)	
	Regulated	**Unregulated**
Baseline B. Regs Compliant (2010)	29.56	14.76
London Plan Target (25% improvement)	22.17	14.76
After Demand Reduction	17.89	14.76
After Renewables	10.72	14.76

The resulting percentage reductions in regulated carbon dioxide emissions are given in the table below

Table 2: Regulated Carbon dioxide savings from each stage of the Energy Hierarchy

	Regulated Carbon dioxide savings	
	Tonnes CO^2 / annum	**%**
Baseline Building Regs TER	29.56	
Savings from demand reduction	11.68	39.5%
Savings from renewable energy	7.17	24.3%
Total Cumulative Savings	18.85	63.8%



Lastly; the percentage reductions in total (unregulated + regulated) carbon dioxide emissions are given in the table below.

Table 3: Total Carbon dioxide savings from Renewables

	Regulated + Unregulated Carbon dioxide savings	
	Tonnes CO^2 / annum	**%**
Total CO2 after Demand Reduction	32.65	
Savings from renewable energy	7.17	20.0%

2.0 Energy Hierarchy

2.1 Demand Reduction

The "regulated" CO_2 Emissions were calculated using recognised SAP software, NHER Plan Assessor V.5.5.2. for represenative residential units.

The calculations take into account a number of "energy demand reduction" measures, which are summarised in the table opposite.

2.2 Efficient Infrastructure

2.2.1 District Heating (not available)

Having established the CO_2 emissions after applying demand reduction measures, the next step was to investigate the use of efficient heating and cooling networks. The London heat map (see below) indicates there are no existing, or proposed district heating mains nearby. The closest, at the Royal Free Hospital is more than 1000m away.

2.2.2 Sitewide Heating

Although there is currently no district heating locally available it would be prudent to design the heating systems such that future connection is not precluded. For this reason a wet heating system (eg radiators, or fan convectors, or underfloor heating) would be preferable to electric heatersor air-to-air heat pumps. With a wet heating system the heat source can be swapped for a district heating plate heat exchanger - should district heating ever become available - without requiring the rest of the heating system to be replaced.

2.2.3 CHP (not proposed)

CHP is really only economically viable for much larger developments.

2.3 On-site Renewables (proposed)

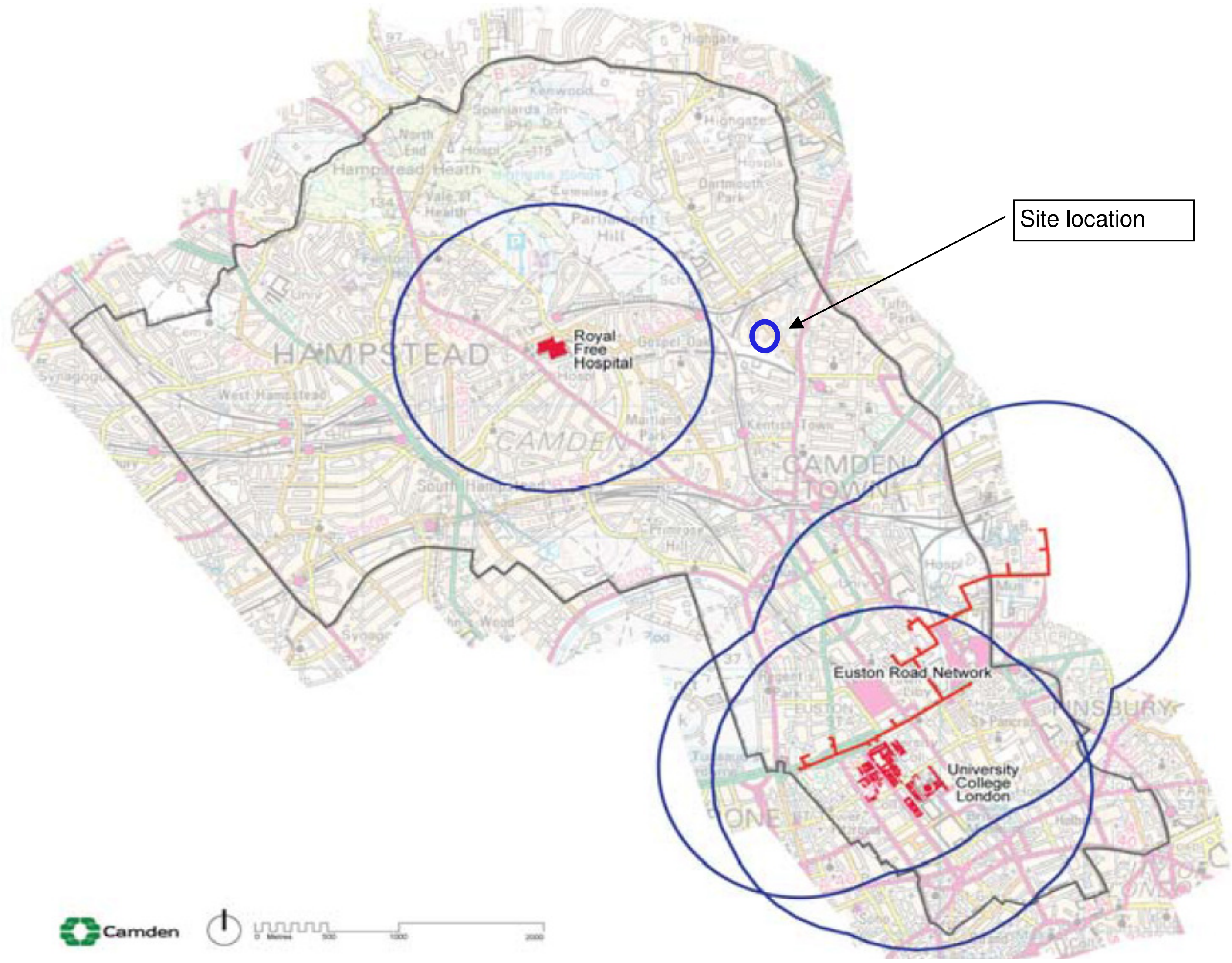
A number of renewable energy sources were looked at; Solar (PV and thermal), Wind, Biomass and Heat Pumps.

Our proposed strategy is wet heating Heating using centralised heat pumps "topped-up" with roof-mounted photovoltaics.This is described in more detail in section 3.

Table 4: Energy Efficiency Measures - "Be Lean"

Element or System	Reference value	Demand Reduction Proposal	Comment
Wall U-Values	0.35	0.15	Requires extra 100 mm P.U. insulation
Floor U-Values	0 (Intermediate Floor)	0	
Roof U-Values	0.16	0.1	Requires extra 100 mm P.U. insulation
Opaque Door	2	0.55	Requires extra 10 mm P.U. insulation
Thermal Bridging	0.11	0.05	Requires robust details
Windows Areas U- Values Frame Factor Solar Energy Trans. Light Trans.	All East or West Facing 25% of floor area = 1.8 0.7 0.51 0.67	 1.3 0.7 0.51 0.67	 Requires low-e triple glazing with argon fill
Ventilation system	Natural Ventilation with Intermittent extract fans	Continuous Mechanical Extract with SFP= 0.17 W/l/s	
Extract Fans	3 Fans per apt	Centralised extract system	
Hot Water Cylinder	150l Cylinders with 35mm factory foam	150l Cylinders with 80mm factory foam	
Primary Losses	Primary pipework not insulated, cylinder temp controlled by thermostat	Primary and secondary pipework insulated. Time and temperature control of cylinder.	
Secondary Space Htg	10% Elec	10% Elec	
Low-e light fittings	70% of fixed outlets	100% of fixed outlets	
Heating Fuel	Natural Gas	Natural Gas	
Heating System	Boiler – SEDBUK 78% efficient room-sealed fanned flue appliance	Boiler – SEDBUK 80% efficient room-sealed fanned flue appliance	
Heating Controls	Programmer + room thermostat + TRVs + boiler interlock		
Hot Water System	Stored water, heated by boiler, separate timers for HTG and DHW	Stored water, heated by boiler, separate timers for HTG and DHW	

Figure 4. Developments within 1km radius of an existing or emerging network.



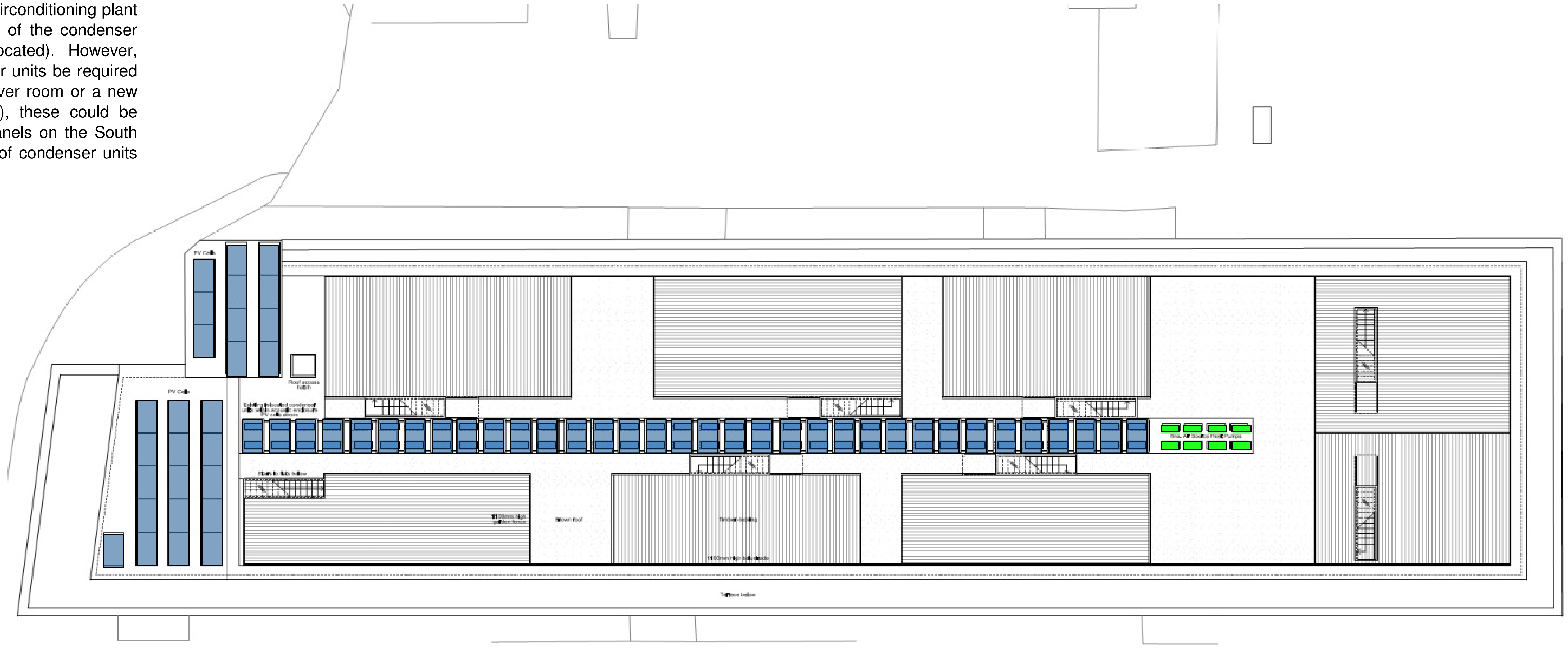
3.0 Detailed Proposal

Our proposal involves relocating Approximately 67 No. Existing condenser units (which serve air-conditioning plant in the offices below) onto the new roof and instaklluing an additional 8 No. Air Source Heat Pumps to provide heat and domestic hot water for the proposed new apartments.

The condenser units are currently somewhat scattered across the existing roof. The intention is to collect them into a central area as shown.

It is proposed to have approximately 60 No. PV panels (15KWp) located at roof level with the relocated condenser units tucked underneath them.

It is unlikely that any other form of roof plant will be required for the offices - the boiler plant is at ground level and the airconditioning plant already exists (in the form of the condenser units that are being relocated). However, should additional condenser units be required in the future (say for a server room or a new meeting room or suchlike), these could be located beneath the PV panels on the South East corner, which is free of condenser units under the current propsals.



PV PANEL 1600x950, TILT =15 Deg ABOVE HORIZ., DIR = DUE SOUTH +/- 45 Deg

EXISTING RELOCATED CONDENSER UNIT TYP. 800x350x650h

NEW RESIDENTIAL ASHP UNIT TYP. 800x350x650h

Appendix I

Establishing the targets -

Energy Calculations

Establishing the targets - SAP calculations

Core Strategy 13 , para 13.11 states that developments will be expected to demonstrate a 20% reduction in CO2 emmissions from on-site renewable energy generation.

SAP software (NHER "Plan Assessor" v5.4.2) was used as follows:

1. The target for Regulated CO2 emissions for building regulations compliance (TER) was calculated for three representative flat types (NW corner, SE corner and W mid-facade). The resulting Target emmissions were averaged and extrapolated across the total floor area to give an overall "Baseline" figure for the development.

2. The *Regulated* CO2 emissions (DER) after energy reduction measures were calculated and extrapolated across the whole development

3. *Unregulated* were calculated us ing the NHER Plan Assessor software and extrapolated across the whole development

A SAP worksheet for one of the apartments is given on the following pages, for information.

Full calculations are available on request.

Baseline: Building Regs TER from SAP calculations				Total CO2 Emissions (kg/year)	
Representative flats for SAP:	Flat SE	Flat NW	Flat Mid	Sum of Samples	Extrapolate to overall area
	160.0 m2	102.0 m2	88.0 m2	350.0 m2	950.0 m2
	kg/m2	kg/m2	kg/m2	kg	T/yr
1. TER from SAP	30.04	32.03	32.03	10892.10	29.56
2. Unregulated CO2 emissions	13.42	16.85	17.86	5437.55	14.76
				Regulated + Unregulated	44.32

Be Lean: Emissions after Energy Efficiency Improvements				Total CO2 Emissions (kg/year)	
Representative flats for SAP:	Flat SE	Flat NW	Flat Mid	Sum of Samples	Extrapolate to overall area
	160.0 m2	102.0 m2	88.0 m2	350.0 m2	950.0 m2
	kg/m2	kg/m2	kg/m2	kg	T/yr
1. Regulated CO2, DER	15.98	22.61	19.63	6590.46	17.89
2. Unregulated CO2 emissions	13.42	16.85	17.86	5437.55	14.76
				Regulated + Unregulated	32.64

Be Green: Emissions after PV Added				Total CO2 Emissions (kg/year)	
Representative flats for SAP:	Flat SE	Flat NW	Flat Mid	Sum of Samples	Extrapolate to overall area
	160.0 m2	102.0 m2	88.0 m2	350.0 m2	950.0 m2
	kg/m2	kg/m2	kg/m2	kg	T/yr
1. Regulated CO2, DER	10.44	13.67	10.04	3948.26	10.72
2. Unregulated CO2 emissions	13.42	16.85	17.86	5437.55	14.76
				Regulated + Unregulated	25.47
				%ge Reduction	22.0%

L1A 2010 - Regulations Compliance Report

Design - Draft

This design draft submission provides evidence towards compliance with Part L of the Building Regulations, in accordance with Appendix A of AD L1A. It has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the 'as built' property. This report covers only items included within the SAP and is not a complete report of regulations compliance.

Assessor name	Mr Thabs Cain	Assessor number	2
Client		Last modified	25/01/2013
Address	8 Linton House 1, London		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxide emission from proposed dwelling does not exceed the target			
TER (kg CO_2/m^2.a)	Fuel = Electricity Fuel factor = 1.47 TER = 30.04	Authorised SAP Assessor	
DER for dwelling as designed (kg CO_2/m^2.a)	DER = 10.44	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 10.44 < TER 30.04	Authorised SAP Assessor	Passed
Criterion 2: the performance of the building fabric and the heating, hot water and fixed lighting systems should be no worse than the design limits			
Fabric U-values			
Are all U-values better than the design limits in Table 2?	Element / Weighted average / Highest Wall 0.18 (max 0.30) 0.18 (max 0.70) Party wall 0.00 (max 0.20) N/A Floor 0.10 (max 0.25) 0.10 (max 0.70) Roof 0.10 (max 0.20) 0.10 (max 0.35) Openings 1.30 (max 2.00) 1.30 (max 3.30)	Authorised SAP Assessor	Passed
Thermal bridging			
How has the loss from thermal bridges been calculated?	Thermal bridging calculated from linear thermal transmittances for each junction	Authorised SAP Assessor	
Heating and hot water systems			
Does the efficiency of the heating systems meet the minimum value set out in the Domestic Heating Compliance Guide?	Main heating system: Heat pump - wet system from database, Electricity Mitsubishi ECODAN 5kW PUHZ-W50VHA-BS Secondary heating system: Room heaters - Electricity Panel, convector or radiant heaters	Authorised SAP Assessor	
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	Cylinder volume = 150.00 litres Nominal cylinder loss = 1.61kWh/day Maximum permitted cylinder loss = 1.89kWh/day Primary hot water pipes are insulated	Authorised SAP Assessor	Passed
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control Hot water control: Boiler interlock (main system 1) Cylinder thermostat Separate water control	Authorised SAP Assessor	Passed

Check	Evidence	Produced by	OK?
Fixed internal lighting			
Does fixed internal lighting comply with paragraphs 42 to 44?	Schedule of installed fixed internal lighting Standard lights = 0 Low energy lights = 20 Percentage of low energy lights = 100 % Minimum = 75 %	Authorised SAP Assessor	Passed
Criterion 3: the dwelling has appropriate passive control measures to limit solar gains			
Does the dwelling have a strong tendency to high summertime temperatures?	Overheating risk (June) = Not significant Overheating risk (July) = Slight Overheating risk (August) = Slight Region = Thames Thermal mass parameter = 250.00 Ventilation rate in hot weather = 6.00 ach Blinds/curtains = Light-coloured curtain or roller blind	Authorised SAP Assessor	Passed
Criterion 4: the performance of the dwelling, as designed, is consistent with the DER			
Design air permeability ($m^3/(h.m^2)$ at 50Pa)	Design air permeability = 3.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Mechanical extract ventilation: SFP = 0.17 W/(litre/sec) Max SFP = 0.7 W/(litre/sec)	Authorised SAP Assessor	Passed
Have the key features of the design been included (or bettered) in practice?	The following walls/wall have a U-value less than $0.2W/m^2K$: • Wall 1 (0.18) • Wall 2 (0.18) • Wall 3 (0.00) • Wall 4 (0.00) The following floors/floor have a U-value less than $0.2W/m^2K$: • Floor 1 (0.10) The following roofs/roof have a U-value less than $0.13W/m^2K$: • Roof 1 (0.10) The following openings have a U-value less than $1.5W/m^2K$: • Window reference 1 (1.30) • Window reference 2 (1.30) • Solid door reference 3 (1.20) Design air permeability of 3 $m^3/(h.m^2)$ is less than 5 $m^3/(h.m^2)$ at 50 Pa Secondary heating system present - Electricity Use of the following low carbon or renewable technologies: • Photovoltaic array	Authorised SAP Assessor	

Code for Sustainable Homes (November 2010)
Design - Draft

NHER

This report details the calculations and results for Ene 1, 2 and 7 of the Code For Sustainable Homes.

This Design Assessment has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed. Code calculations are from the Technical Guide (November 2010).

Assessor name	Mr Thabs Cain	Assessor number	2
Client		Last modified	25/01/2013
Address	8 Linton House 1, London		

Building regulation assessment - criterion 1

	kg/m²/yr
DER	10.44
TER	30.04

Assessment of zero carbon home and low or zero carbon technologies

		Credits	Level
Dwelling emission rate (Ene 1)	CO_2 reduction = 65.2 %	6.4	4
Fabric Energy Efficiency	FEE = 53.1	No credits	
Low or zero carbon technologies (Ene 7)	CO_2 reduction = 20 %	2	

Ene 1 - dwelling emission rate

	%	kWh/m²	$kgCO_2/m^2/yr$	
Assessment of Ene 1 (level 1-5)				
DER from SAP 2009 DER worksheet			10.44	
Additional allowable generation		0.00		
CO_2 emissions offset from generation			0.00	
CO_2 emissions offset from community biofuel CHP systems			0.00	
Total CO_2 emissions offset from SAP section 16 allowances			0.00	
DER accounting for SAP section 16 allowances			10.44	
CO_2 reduction compared to TER			19.60	
CO_2 reduction as % of TER	65.2			
Assessment of Ene 1 (level 6)				
DER from SAP 2009 DER worksheet			10.44	(ZC1)
CO_2 emissions from appliances (equation L14)			12.23	(ZC2)
CO_2 emissions from cooking (equation L16)			1.19	(ZC3)
Total CO_2 emissions			23.86	(ZC4)
Additional allowable generation and its CO_2 emissions offset		0.00		(ZC6)
CO_2 emissions offset from additional allowable generation			0.00	(ZC7)
CO_2 emissions offset from community biofuel CHP systems			0.00	(ZC5)
Net CO_2 emissions			23.86	(ZC8)

Ene 1 - dwelling emission rate - level 6

There is no Zero Carbon Home definition in the current technical guide

	Criterion	Value	Pass/Fail
FEE	<= 39	53.1	Fail
Net CO_2 emissions	<= 0.00	23.86	Fail

Result: Not level 6

Number of credits for Ene 1: 6.4

Ene 2 - Fabric Energy Efficiency

FEE	53.1
Number of credits for Ene 2	No credits

Ene 7 - low or zero carbon technologies

	Emissions $kgCO_2/yr$	Reduction $kgCO_2/yr$
Standard case		
Space and water heating (265)	2210.74	
Mechanical cooling (266)	0.00	
Pumps and fans (267)	149.58	
Lighting (268)	269.59	
Appliances and cooking	2146.62	
Total CO_2	4776.53	
Actual case		
Space and water heating (265) or (376)	2228.39	
Space and water heating from LZCT considered in SAP 2009		17.65
Pumps and fans (267) or (378)	59.10	
Pumps and fans		-90.47
Electricity generated by LZCT (269) + (380))		-886.05
Additional allowable electricity generation considered in SAP 2009 section 16		0.00
Offset from biofuel CHP [-1 x [(363)..(366) + (368)...(372)]]		0.00
LZCT electricity generation		-886.05
LZCT thermal generation		-72.82
Total from specified LZCT		-958.87

Reduction in CO_2 Emissions		Emissions $kgCO_2/m^2/yr$
Standard Case CO_2		29.86
Actual Case CO_2		23.86
% Reduction in CO_2	20	
Number of credits for Ene 7	2	

DER 2009 Worksheet

Design - Draft

NHER

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Assessor name	Mr Thabs Cain	Assessor number	2
Client		Last modified	25/01/2013
Address	8 Linton House 1, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		160.00	(1a)	x	2.65	(2a)	=	424.00	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	160.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			424.00	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)

Air permeability value applies if a pressurisation test has been done, or a design or specified air permeability is being used

Number of sides on which dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Adjusted infiltration rate	(18) x (20) =	0.13	(21)

Infiltration rate modified for monthly wind speed:

Monthly average wind speed from Table 7

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(22)m	5.40	5.10	5.10	4.50	4.10	3.90	3.70	3.70	4.20	4.50	4.80	5.10	

∑(22)1...12 = 54.10 (22)

Wind Factor (22a)m = (22)m ÷ 4

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22a)m	1.35	1.27	1.27	1.12	1.02	0.98	0.92	0.92	1.05	1.12	1.20	1.27

∑(22a)1...12 = 13.52 (22a)

Adjusted infiltration rate (allowing for shelter and wind speed) = (21) × (22a)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(22b)m	0.17	0.16	0.16	0.14	0.13	0.12	0.12	0.12	0.13	0.14	0.15	0.16

∑(22b)1...12 = 1.72 (22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.5	(23a)
If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)), otherwise (23b) = (23a)	0.5	(23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = N/A (23c)

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 x (23b), then (24c) = (23b); otherwise (24c) = (22b)m + 0.5 x (23b)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(24c)m	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(24c)

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in box (25)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(25)m	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	(25)

3. Heat losses and heat loss parameter

The κ-value is the heat capacity per unit area, see Table 1e.

Element	Gross Area, m²	Openings, m²	Net area A, m²		U-value, W/m²K		A x U, W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window*			94.92	x	1.24	=	117.30	N/A	N/A	(27)
Doors			1.62	x	1.20	=	1.94	N/A	N/A	(26)
Exposed floor			160.00	x	0.10	=	16.00	N/A	N/A	(28b)
External wall			6.18	x	0.18	=	1.11	N/A	N/A	(29a)
Party Wall			55.38	x	0.00	=	0.00	N/A	N/A	(32)
Roof			160.00	x	0.10	=	16.00	N/A	N/A	(30)
Total area of external elements ∑A, m²			422.72	(31)						

** for windows and roof windows, effective window U-value is calculated using formula 1/[(1/UValue)+0.04] paragraph 3.2*

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	152.35	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K	Calculated separately =	250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		39.06	(36)

if details of thermal bridging are not known then (36) = 0.15 x (31)

Total fabric heat loss	(33) + (36) =	191.42	(37)

Ventilation heat loss calculated monthly 0.33 x (25)m x (5)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(38)m	69.96	69.96	69.96	69.96	69.96	69.96	69.96	69.96	69.96	69.96	69.96	69.96	(38)

Heat transfer coefficient, W/K (37)m + (38)m

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(39)m	261.38	261.38	261.38	261.38	261.38	261.38	261.38	261.38	261.38	261.38	261.38	261.38

Average = ∑(39)1...12/12 = 261.38 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(40)m	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63	1.63

Average = ∑(40)1...12/12 = 1.63 (40)

4. Water heating energy requirement

	kWh/year	
Assumed occupancy, N	2.95	(42)

If TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA - 13.9)²)] + 0.0013 x (TFA - 13.9)

If TFA ≤ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	104.24	(43)

Annual average hot water usage has been reduced by 5% if the dwelling is designed to achieve a water use target of not more than 125 litres per person per day (all water use, hot and cold)

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(44)m	114.66	110.49	106.32	102.15	97.98	93.81	93.81	97.98	102.15	106.32	110.49	114.66

∑(44)1...12 = 1250.84 (44)

Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
(45)m	170.44	149.07	153.83	134.11	128.68	111.04	102.90	118.08	119.49	139.25	152.00	165.07

∑(45)1...12 = 1643.97 (45)

If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)

For community heating include distribution loss whether or not hot water tank is present

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss 0.15 x (45)m													
(46)m	25.57	22.36	23.07	20.12	19.30	16.66	15.43	17.71	17.92	20.89	22.80	24.76	(46)

Water storage loss:

b) If manufacturer's declared cylinder loss factor is not known:

Cylinder volume (litres) including any solar storage within same cylinder	150.00	(50)
If community heating and no tank in dwelling, enter 110 litres in box (50)		
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in box (50)		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.01	(51)
If community heating see SAP 2009 section 4.3		
Volume factor from Table 2a	0.93	(52)
Temperature factor from Table 2b	0.54	(53)
Energy lost from water storage, kWh/day (50) x (51) x (52) x (53)	0.87	(54)
Enter (49) or (54) in (55)	0.87	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month = (55) x (41)m													
(56)m	26.92	24.31	26.92	26.05	26.92	26.05	26.92	26.92	26.05	26.92	26.05	26.92	(56)
If cylinder contains dedicated solar storage, = (56)m x [(50) - (H11)] ÷ (50), else = (56)m where (H11) is from Appendix H													
(57)m	26.92	24.31	26.92	26.05	26.92	26.05	26.92	26.92	26.05	26.92	26.05	26.92	(57)

Primary circuit loss (annual) from Table 3 | 360.00 | (58)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Primary circuit loss for each month (58) ÷ 365 × (41)m (modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)													
(59)m	30.58	27.62	30.58	29.59	30.58	29.59	30.58	30.58	29.59	30.58	29.59	30.58	(59)
Combi loss for each month from Table 3a, 3b or 3c (enter '0' if not a combi boiler)													
(61)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m													
(62)m	227.94	201.00	211.32	189.75	186.18	166.68	160.39	175.57	175.13	196.74	207.64	222.56	(62)
Solar DHW input calculated using Appendix H (negative quantity) ('0' entered if no solar contribution to water heating)													
(63)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
											∑(63)1…12 =	0.00	(63)
Output from water heater for each month, kWh/month (62)m + (63)m													
(64)m	227.94	201.00	211.32	189.75	186.18	166.68	160.39	175.57	175.13	196.74	207.64	222.56	
											∑(64)1…12 =	2320.90	(64)

if (64)m < 0 then set to 0

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat gains from water heating, kWh/month 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]													
(65)m	102.67	91.11	97.14	89.10	88.78	81.43	80.21	85.26	84.24	92.30	95.05	100.88	(65)

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

5. Internal gains (see Table 5 and 5a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5), Watts													
(66)m	147.45	147.45	147.45	147.45	147.45	147.45	147.45	147.45	147.45	147.45	147.45	147.45	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
(67)m	29.53	26.23	21.33	16.15	12.07	10.19	11.01	14.31	19.21	24.39	28.47	30.35	(67)
Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
(68)m	331.20	334.64	325.98	307.54	284.27	262.39	247.78	244.34	253.00	271.44	294.72	316.59	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
(69)m	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	37.74	(69)
Pumps and fans gains (Table 5a)													
(70)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Losses e.g. evaporation (negative values) (Table 5)													
(71)m	-117.96	-117.96	-117.96	-117.96	-117.96	-117.96	-117.96	-117.96	-117.96	-117.96	-117.96	-117.96	(71)
Water heating gains (Table 5)													
(72)m	137.99	135.58	130.57	123.75	119.33	113.10	107.81	114.59	117.00	124.05	132.02	135.59	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
(73)m	565.96	563.68	545.11	514.68	482.90	452.92	433.83	440.48	456.45	487.12	522.43	549.76	(73)

6. Solar gains

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

Rows (74) to (82) are used 12 times, one for each month, repeating as needed if there is more than one window type.

Details for month of January and annual totals are shown below:

	Access factor Table 6d		Area m²		Solar flux W/m²		g Specific data or Table 6b		FF Specific data or Table 6c		Gains (W)	
Southwest	0.77	x	67.20	x	37.39	x 0.9 x	0.57	x	0.80	=	793.95	(79)
Southeast	0.77	x	27.72	x	37.39	x 0.9 x	0.57	x	0.80	=	327.51	(77)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains in watts, calculated for each month ∑(74)m…(82)m													
(83)m	1121.46	1911.77	2526.10	3104.20	3399.59	3450.80	3383.22	3159.75	2786.50	2170.56	1344.56	958.35	(83)
Total gains - internal and solar (73)m + (83)m													
(84)m	1687.42	2475.45	3071.21	3618.88	3882.49	3903.72	3817.05	3600.22	3242.95	2657.68	1866.99	1508.11	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C) | 21.00 | (85)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area, η1,m (see Table 9a)													
(86)m	0.98	0.94	0.86	0.74	0.58	0.42	0.28	0.30	0.52	0.79	0.96	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
(87)m	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	21.00	(87)
Temperature during heating periods in the living area from Table 9, Th2(°C)													
(88)m	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	(88)
Utilisation factor for gains for rest of dwelling η2,m (see Table 9a)													
(89)m	0.98	0.92	0.83	0.69	0.51	0.33	0.18	0.20	0.42	0.73	0.95	0.98	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
(90)m	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	19.59	(90)

Living area fraction fLA | 65.00 | ÷ (4) = | 0.41 | (91)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
(92)m	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	(92)
Apply adjustment to the mean internal temperature from Table 4e, where appropriate													
(93)m	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	20.16	(93)

8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that tim = (93)m and recalculate the utilisation factor for gains using Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
(94)m	0.98	0.93	0.84	0.71	0.54	0.37	0.22	0.24	0.46	0.76	0.95	0.98	(94)
Useful gains, ηmGm, W = (94)m x (84)m													
(95)m	1653.80	2305.06	2582.42	2578.85	2094.52	1433.60	851.20	850.71	1485.95	2017.98	1780.58	1485.40	(95)
Monthly average external temperature from Table 8													
(96)m	4.50	5.00	6.80	8.70	11.70	14.60	16.90	16.90	14.30	10.80	7.00	4.90	(96)
Heat loss rate for mean internal temperature, Lm, W													
(97)m	4094.40	3963.71	3493.23	2996.62	2212.49	1454.49	853.33	853.33	1532.91	2447.73	3440.96	3989.85	(97)
Space heating requirement for each month, kWh/month = 0.024 x [(97)m - (95)m] x (41)m													
(98)m	1815.80	1114.62	677.65	300.79	87.77	0.00	0.00	0.00	0.00	319.73	1195.47	1863.31	

	Total per year (kWh/year) = ∑(98)1...5, 10...12 =	7375.14	(98)
Space heating requirement in kWh/m²/year	(98) ÷ (4)	46.09	(99)

9a. Energy Requirements - Individual heating systems including micro-CHP

Space heating:

Fraction of space heating from secondary/supplementary system (Table 11)	0.00	(201)
Fraction of space heating from main system(s) 1 - (201)	1.00	(202)
Fraction of main heating from main system 2	0.00	(203)
Fraction of total space heat from main system 1 (202) x [1 - (203)]	1.00	(204)
Fraction of total space heat from main system 2 (202) x (203)	0.00	(205)
Efficiency of main space heating system 1 (%)	328.19	(206)

(from database or Table 4a/4b, adjusted where appropriate by the amount shown in the 'space efficiency adjustment' column of Table 4c)

Efficiency of secondary/supplementary heating system, from Table 4a or Appendix E (%)	100.00	(208)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating requirement, kWh/month (as calculated above)												
(98)m	1815.80	1114.62	677.65	300.79	87.77	0.00	0.00	0.00	0.00	319.73	1195.47	1863.31
Space heating fuel (main heating system 1), kWh/month = (98)m x (204) x 100 ÷ (206)												
(211)m	553.28	339.62	206.48	91.65	26.74	0.00	0.00	0.00	0.00	97.42	364.26	567.75

Total per year (kWh/year) = ∑(211)1...5, 10...12 = 2247.21 (211)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (secondary), kWh/month = (98)m x (201) x 100 ÷ (208)												
(215)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Total per year (kWh/year) = ∑(215)1...5, 10...12 = 0.00 (215)

Water heating:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Output from water heater, kWh/month (calculated above)												
(64)m	227.94	201.00	211.32	189.75	186.18	166.68	160.39	175.57	175.13	196.74	207.64	222.56

∑(64)1...12 = 2320.90 (64)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Efficiency of water heater per month												
(217)m	112.50	112.50	112.50	112.50	112.50	112.50	112.50	112.50	112.50	112.50	112.50	112.50
Fuel for water heating, kWh/month = (64)m x 100 ÷ (217)m												
(219)m	202.61	178.67	187.84	168.67	165.49	148.16	142.57	156.06	155.67	174.88	184.57	197.83

Total per year (kWh/year) = ∑(219)1...12 = 2063.02 (219)

Annual Totals Summary:	kWh/year	kWh/year	
Space heating fuel used, main system 1		2247.21	(211)
Space heating fuel used, secondary		0.00	(215)
Water heating fuel used		2063.02	(219)
Electricity for pumps, fans and electric keep-hot (Table 4f):			
mechanical ventilation fans - balanced, extract or positive input from outside	114.32		(230a)
warm air heating system fans	0.00		(230b)
central heating pump	0.00		(230c)
oil boiler pump	0.00		(230d)
boiler flue fan	0.00		(230e)
maintaining electric keep-hot facility for gas combi boiler	0.00		(230f)
pump for solar water heating	0.00		(230g)
Total electricity for the above	∑(230a)...(230g)	114.32	(231)
Electricity for lighting (calculated in Appendix L):		521.46	(232)
Energy saving/generation technologies (Appendices M, N and Q):			
Electricity generated by PVs (Appendix M) (negative quantity)		-1674.96	(233)

12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

	Energy kWh/year		Emissions Factor		Emissions (kgCO2/year)	
Space heating - main system 1	2247.21	x	0.517	=	1161.81	(261)
Space heating - secondary	0.00	x	0.517	=	0.00	(263)
Water heating	2063.02	x	0.517	=	1066.58	(264)
Space and water heating			(261) + (262) + (263) + (264) =		2228.39	(265)
Pumps, fans and electric keep-hot	114.32	x	0.517	=	59.10	(267)
Lighting	521.46	x	0.517	=	269.59	(268)
Energy saving/generation technologies:						
PV emission savings (negative quantity)	-1674.96	x	0.529	=	-886.05	(269)
Total carbon dioxide emissions			∑(261)...(271) =		1671.03	(272)
Dwelling Carbon Dioxide Emissions Rate (DER)					10.44	(273)

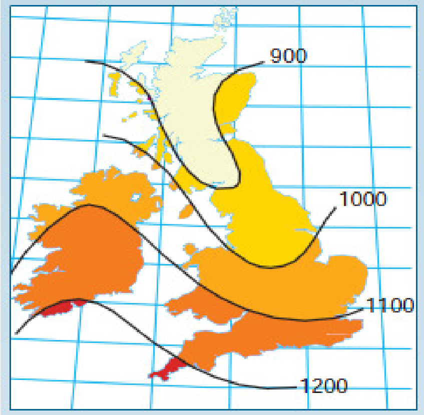
Appendix II

Feasibility Study for Proposed Strategy

Renewable: Photovoltaics

1. SITE ANALYSIS

Incoming annual radiation	1,100 kWh/m2
Tilt	30 deg
Direction (S=0, W=90, E=-90)	30 deg
Correction Factor	98%
Shading	None
Shading Correction Factor	1.00
Inverter loss Correction Factor	91%
Dist'n loss Correction Factor	97%
Balance Of System C.F.	85%
Total Combined Correction Factor	73.5%
Corrected annual radiation	**809 kWh/m2**



Annual radiation kWh/m2
For South-facing @30 deg tilt

Tilt	Annual output as percentage of maximum for stated orientation (with respect to due south) and tilt / %												
	−90° West	−75°	−60°	−45° SW	−30°	−15°	0° South	15°	30°	45° SE	60°	75°	90° East
Vertical	56	60	64	67	69	71	71	71	71	69	65	62	58
80°	63	68	72	75	77	79	80	80	79	77	74	69	65
70°	69	74	78	82	85	86	87	87	86	84	80	76	70
60°	74	79	84	87	90	91	93	93	92	89	86	81	76
50°	78	84	88	92	95	96	97	97	96	93	89	85	80
40°	82	86	90	95	97	99	100	99	98	96	92	88	84
30°	86	89	93	96	97	99	100	100	98	96	94	90	86
20°	87	90	93	96	97	98	98	98	97	96	94	91	88
10°	89	91	92	94	97	95	96	95	95	94	93	91	90
Horizontal	90	90	90	90	90	90	90	90	90	90	90	90	90

Correction for tilt and direction

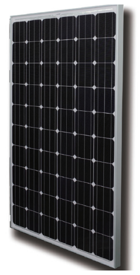
	%ge of sky blocked by obstacles	Correction Factor
None	<20%	1.00
Modest	20-60%	0.80
Significant	60-80%	0.65
Heavy	80-100%	0.50

Correction for sky obstructions

2. PANEL SELECTION

Chosen Panel	HIT 250
Manufacturer	Sanyo
Dims	1610 x 861 x 35
Output at 1000 W/m2 radiation	250 W
Annual corrected output	202 kWh
Annual output per m2	146 kWh/m2
Installed Cost per m2	£400

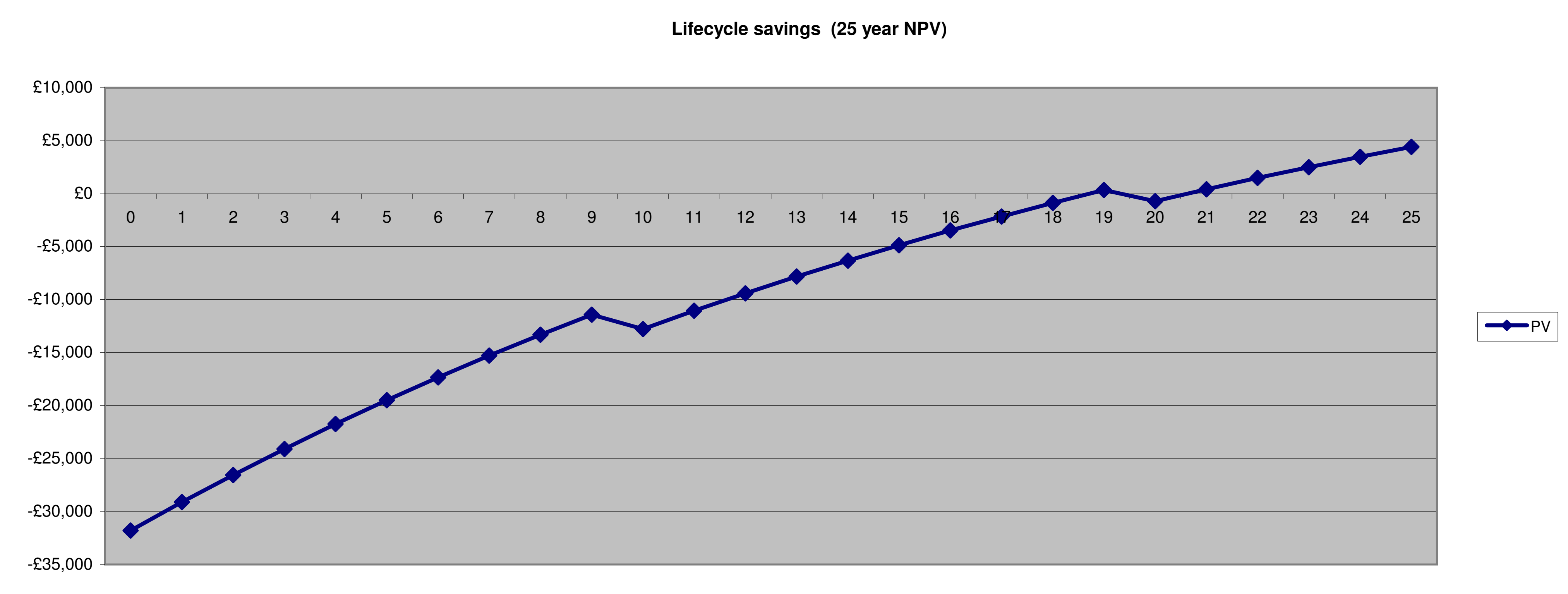
Manufacturer's information

MBPV240	HIT 250	STP 250		
MoserBaer	Sanyo	Suntech		
1661 x991 x 40	1610 x 861 x 35	1665 x991 x 50		
240 W	250 W	250 W		
118 kWh/m2	146 kWh/m2	123 kWh/m2		
£350	£400	£250		
				

3. TARGET CO2 REDUCTION

Target (from Appendix I)	**6,528 kg CO2**
CO2 saved per kWh	0.517
KWh to achieve target	12,627kWh
Peak Output Required	16 kW
Panel Area Required	**87 m2**
Installed Cost	**£34,625**
Annual maintenance (@1.5%)	£519
Replace inverters (10 yearly)	£4,500
Output drop (per year)	1.5%
Feed-in Tariff	13.0 p/kWh
Duration	25 years
Year 1 FIT	£1,645
Output used on site	100%
Elec price from grid	13.5 p/kWh
Year 1 Elec Saving	£1,705
Output sold to Grid	0%
Elec price to grid	3.5 p/kWh
Year 1 Elec Sales	£0
SIMPLE PAYBACK	10.5 years
25 year NPV	£92,502
CO2 saved	6,528 kg CO2
%ge renewable	20.0%

Investment Appraisal



4. OTHER CONSIDERATIONS

4.1 Space - approximately 120m2 available on roof.
4.2 Maintenance - annual inspection and occasional repair , but otherwise, fairly minimal
4.3 Noise - not an issue.
4.4 Energy mix - would work well with heat pumps, should not affect future district heating, but would be a bad match for future private-wire electricity from, say, a community CHP system.