53 Fitzroy Park

ENERGY & SUSTAINABILITY STATEMENT

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1	For Planning	CMS	GMW	02.02.17

All information provided here is based on plans and information available at the time of writing. Prior to implementation of the options discussed, further detailed study, design and costing, based on ground surveys, structural analysis, over shading studies, etc., as relevant to each renewable/low carbon source, is necessary.

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Contents

1. EXECUTIVE SUMMARY

The report describes the energy strategy for the proposed new build development at 53 Fitzroy Park. The energy strategy for the site has been developed to comply with the London Borough of Camden carbon emission reductions targets as outlined in the CPG3 guidance on preparing energy statements (July 2015). A 35% reduction in regulated carbon emissions must be achieved as a minimum, with carbon offsetting to deliver the remaining reductions to reach Zero Carbon.

The following strategy has been implemented using the “Be Lean, Be Clean, Be Green” hierarchy;

- “Be Lean”: improvements to the building fabric and energy efficient services to minimize energy demand.
- “Be Clean”: The nearest heat network is over 2.5 miles from the site. The site is too small to support its own CHP, and therefore no savings are available from stage of the hierarchy.
- “Be Green”: Roof-mounted Solar PV arrays provide further reductions in carbon emissions required to achieve the carbon reduction target.

The scheme must meet the London Plan requirements for reducing on-site carbon emissions relative to the baseline of compliance with building regulations, as outlined below.

Carbon emissions for the site before and after each stage of the “Be Lean, Be Clean, Be Green” hierarchy are summarised in Table 1, with the corresponding savings shown in Table 2. An overall carbon reduction of 36.0% is calculated. The savings from each stage of the energy strategy are summarised in Figure 1.

As shown, no savings were achieved by the “Be Lean” stage of the energy hierarchy. This is the result of conservative early-stage assumptions for thermal bridges. It is expected that a significant reduction in CO_2 emissions will be achieved once the design has been developed and thermal bridges can be fully assessed.

No savings are achieved for “Be Clean” since the site is not suitable for connection to, or provision of, a CHP district heating system.

	Carbon Dioxide emissions (Tonnes CO$_2$ per annum)	
	Regulated	Unregulated
Baseline	9.1	6.8
Be Lean	9.6	6.8
Be Clean	9.6	6.8
Be Green	5.8	6.8

Table 1: Carbon dioxide emissions after each stage of the Energy Hierarchy

	Regulated Carbon Dioxide emissions	
	(Tonnes CO$_2$ per annum)	(%)
Savings from energy demand reduction (Be Lean)	-0.5	-5.6%
Savings from CHP (Be Clean)	0.0	0.0%
Savings from renewable energy (Be Green)	3.8	41.6%
Cumulative on site savings	**3.3**	**36.0%**
Annual Savings from off-set Payment	5.8	
Cumulative savings for off-set payment	175	
Off-Set Payment	£10,518	

Table 2: Residential Element carbon savings from Be Lean, Be Clean and Be Green measures.

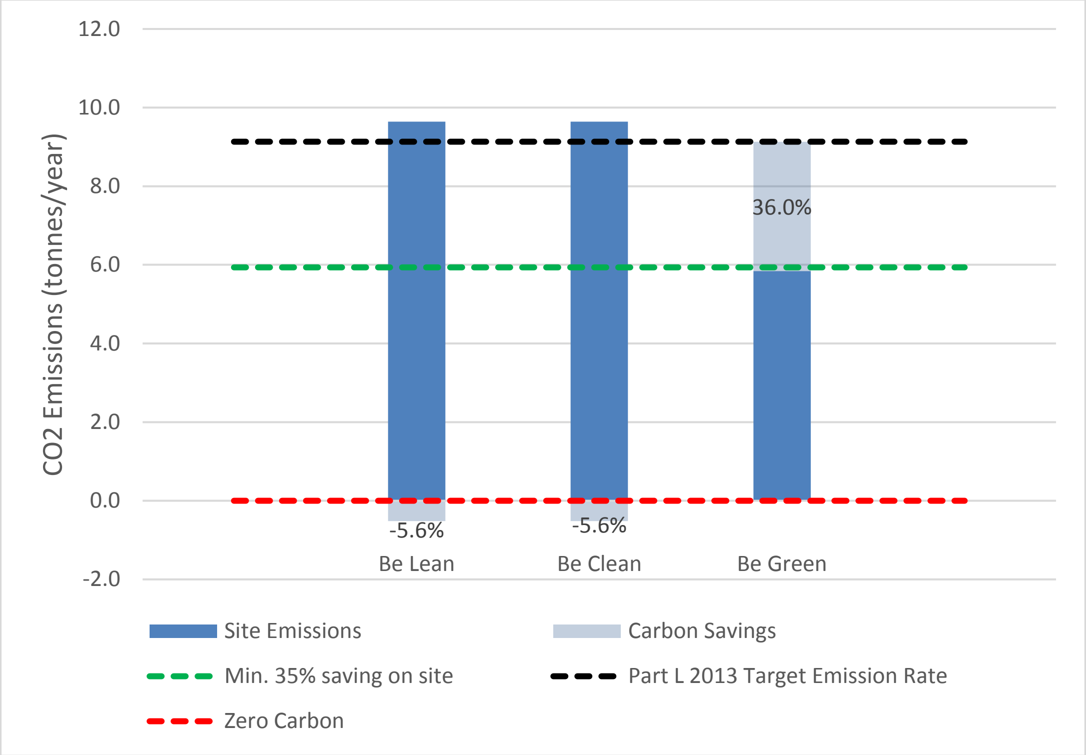

Figure 1: Summary of Residential Element carbon reduction from Be Lean, Be Clean and Be Green measures

2. INTRODUCTION

2.1 Description of the project

The project consists of the construction of a new five-bedroom house on the site of 53 Fitzroy Park.

2.2 Energy & Carbon Emissions Targets

Planning guidance document CPG 3 requires that developments comply with the GLA London Plan policies for carbon reduction. From 1st October 2016, this effectively requires that ‘zero carbon’ must be achieved for developments such as this. This may be achieved by a 35% *minimum* reduction in carbon emissions, plus carbon off-setting to deliver the remaining reduction to achieve 100%. The off-set is implemented through a one-off payment of £60 per tonne of carbon dioxide for a period of 30 years.

Since the CPG 3 document defers to the London Plan approach for the development of energy strategies, this document will generally reference the GLA guidance documentation[1].

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[1] Greater London Authority guidance on preparing energy assessments (March 2016)

3. ESTABLISHING CO_2 EMISSIONS

3.1 Residential CO_2 Emissions

3.1.1 New Development

Regulated energy calculations for the new domestic aspects of this project have been carried out using FSAP 2012 software which is accredited for use in Part L1A CO_2 calculations. The appendix gives the compliance documents for each stage of the process:

1. After Passive & Active Measures (“Be Lean”)
2. After CHP (“Be Clean”)
3. After Renewable energy solutions (“Be Green”)

For the domestic properties the unregulated energy has been calculated using BRE Domestic Energy Model (BREDEM 2012). These calculations can be found in Appendix 3: Supporting SAP Documentation and Appendix 6: Supporting BREDEM calculation.

4. BASELINE

4.1 New Build Areas

To demonstrate the percentage reduction a Baseline CO_2 figure needs to be established. In accordance with section 8.2 of the GLA guidance on preparing energy assessments, the regulated CO_2 emissions was established assuming the development complied with Part L 2013 using Building Regulations Part L approved compliance software (FSAP 2012).

Table 3 below shows the regulated and unregulated baseline figures.

Unregulated energy has been calculated using the BREDEM calculation method.

Carbon Dioxide emissions (Tonnes CO_2 per annum)	
Regulated	Unregulated
9.1	6.8

Table 3: Baseline regulated and unregulated CO_2 emissions

5. DEMAND REDUCTION (BE LEAN)

5.1 Passive Measures

Fabric Properties

U-values for external elements for the Main School and Grotto Site have been improved from the minimum standards set out under Part L, as shown below in Table 4. Glazing properties are set out in Table 5.

Element	U-Value (W/m^2/K)	Part L Notional values
Walls	0.11	0.18
Floors	0.10	0.13
Roof	0.11	0.13
Glazing (windows & rooflights), including frame	1.4	1.4

Table 4: Proposed U-values performance compared with Part L Notional Building.

Glazing	g-value
Windows and Doors (general)	0.6

Table 5: Glazing g-values used

Air tightness

An air permeability of 3m^3/m^2/hr has been targeted.

Thermal Bridges

Details of building junctions have not been developed at this early stage in the design, and therefore it is not possible to assess the potential for thermal bridging. The default allowance for thermal bridges has been included in the SAP model. This is a conservative approach, which is likely to overestimate the carbon site emissions. Thermal bridge analysis at a later stage in the design may allow improved Psi values to be used within the model, improving the carbon reduction.

5.2 Active Measures

Ventilation

- Mechanical Ventilation with heat recovery (Vent Axia Sentinel Kinetic Plus or similar)
- Fitted by a company/persons on an Approved Installation Scheme
- The ducting is required to be insulated where appropriate

Heating

- Condensing Boiler (Vaillant ecoTEC plus 637) 88.9% efficiency
- Time and temperature zone controls
- Weather compensation
- High efficiency pump.

Water heating

- From main heating system
- 500 litres cylinder with 2.14kWh/day standing loss (based on Megaflo Plus)

Lighting

- 100% low energy lighting

Ventilation

- Mechanical Ventilation with heat recovery (Vent Axia Sentinel Kinetic 200ZP or similar)
- Fitted by a company/persons on an Approved Installation Scheme
- The ducting is required to be insulated where appropriate

5.3 Carbon Emissions Reduction

Table 6 shows carbon dioxide emissions for the development before and after applying Be Lean measures. Table 7 shows that carbon emissions have actually increased for this stage of the energy hierarchy. This is the result of assumptions for thermal bridging, which at this stage are set as default in the SAP software. The model result is heavily penalised, and despite having low fabric U-values and air tightness (see 5.1), fails to meet the Part L TER.

It is likely that significant carbon savings would be possible by carrying out calculations to establish actual thermal bridge performance. However, the design is not sufficiently progressed for this work to take place.

Supporting documents from the SAP software can be found in Appendix 3: Supporting SAP Documentation.

	Carbon Dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline	9.1	6.8
Be Lean	9.6	6.8

Table 6: Regulated and unregulated CO_2 emissions for the whole development

	Reduction in Regulated Carbon Dioxide emissions	
	(Tonnes CO_2 per annum)	(%)

Be Lean	-0.5	-5.6%
Min. Target Savings	3.2	35.0%
Shortfall	3.7	40.6%

Table 7: Regulated carbon dioxide savings from Be Lean measures

6. HEATING INFRASTRUCTURE INCLUDING CHP (BE CLEAN)

6.1 Connection to existing heat distribution network

Analysis of the London heat map shows that the nearest *potential* community heating scheme (red line) is over 2.6km from the site, and existing schemes (yellow line) are significantly further than this (see Figure 2). There is therefore no viable opportunity for connection into an existing heat distribution network.

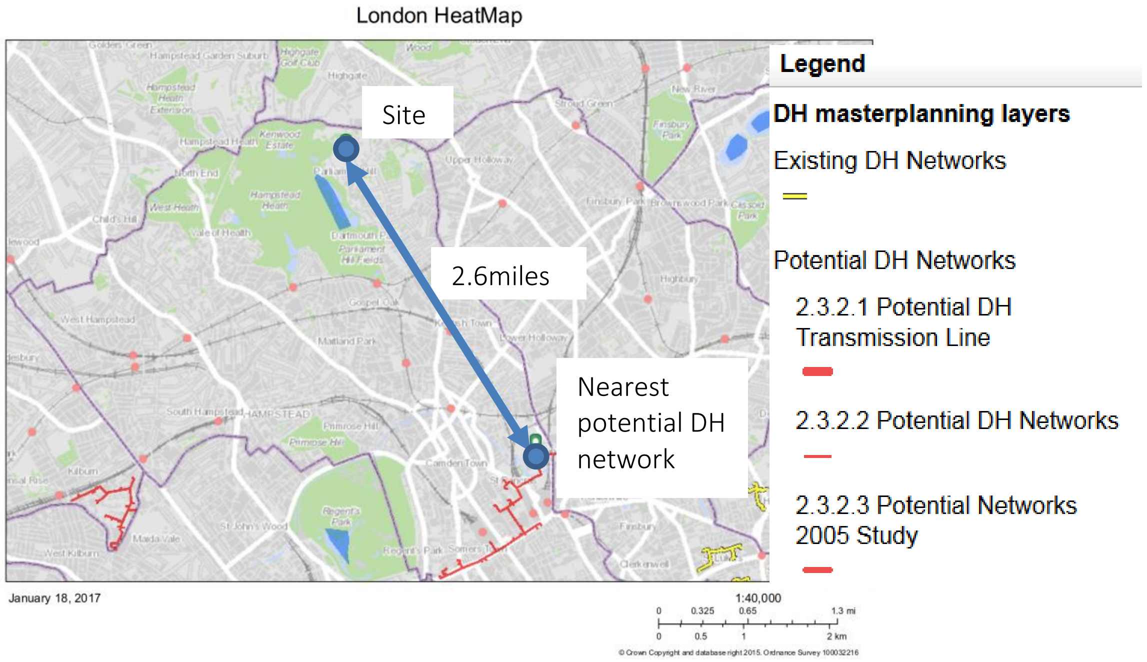


Figure 2: London Heat Map

6.2 Site Wide Heating Network

Combined Heat and Power only becomes economically viable for larger schemes, and is not suited for a single dwelling, which has insufficient thermal and electrical loads. Therefore, this has been ruled out for the site.

6.3 Carbon Emissions Reduction

Since there is no viable district heat network in the area, and since CHP is not suited to such a small development, there are no carbon savings achieved by this stage of the energy hierarchy.

7. RENEWABLE ENERGY (BE GREEN)

7.1 Technology options

An initial review was conducted to eliminate any technologies which from the outset have been identified as unviable. This can be found in Appendix 2: Preliminary Appraisal of Renewable Energy Options. From this study, the following technologies have been identified as suitable for the scheme;

- Solar PV
- Solar Hot Water
- Air Source Heat Pumps

Solar PV

Solar PV panels would provide electrical generation for use on the site, as well as export to the grid when site demand falls below generation. The system would be eligible for the Feed-In-Tarriff and Export Tariff, generating a small income for the client.

There is roof space available for an 8.9kW system, using higher efficiency panels (270W), mounted at around 20deg pitch (see Figure 3).

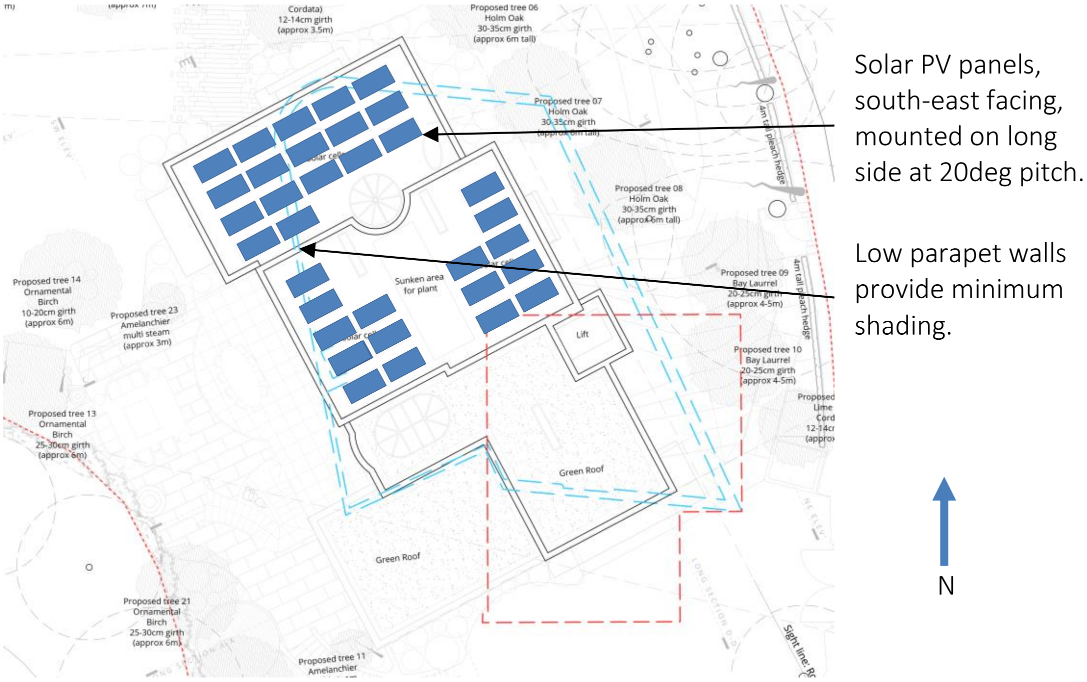


Figure 3: Solar PV system on roof top- indicative layout of panels

Solar Hot Water

A Solar Hot Water system would consist of panels which provide hot water for domestic use. Typically such systems are sized to provide around 50-60% of hot water requirements to avoid the risk of overheating during the summer. This reduces the potential for carbon reduction, and furthermore, the system would compete for roof space with a Solar PV system, which has higher potential to reduce carbon emissions. On this basis a Solar Hot Water system is not recommended for the building.

Air Source Heat Pumps

Air source heat pumps (ASHPs) use the refrigeration cycle to extract heat from ambient air, and transfer this heat into the building's heating and hot water systems. This process requires the input of electrical energy to drive the compressors, so the technology is not truly renewable. However, if the efficiency of this process is high enough, a carbon saving can be made compared to the use of gas boilers.

The performance of an ASHP varies with the external air temperature- the colder it is, the less efficient the heat extraction process is. This means that is it very difficult to predict the performance of such systems. The design of the heating and hot water systems must also be optimised for connection to a heat pump, so that efficiency can be maximised.

An ASHP system could make a significant contribution to reducing carbon emissions for the building, but at this stage will not be included within the proposed strategy.

7.1.1 Preferred Option

A Solar PV system is the preferred option for the site, as it provides a reliable source of low-carbon electricity, and will also benefit from the Feed-In/Export Tariffs.

7.2 Carbon Emissions Reduction

Table 8 shows the carbon emissions of the development before and after Be Lean, Be Clean and Be Clean measures. Table 9 shows the reduction in carbon emissions resulting from Be Lean, Be Clean and Be Green measures, and demonstrates that with Be Green measures applied, the 35% minimum reduction is achieved, with a small surplus.

Supporting documents from the SAP software can be found in Appendix 3: Supporting SAP Documentation.

	Carbon Dioxide emissions (Tonnes CO_2 per annum)	
	Regulated	Unregulated
Baseline	9.1	6.8
Be Lean	9.6	6.8
Be Clean	9.6	6.8
Be Green	5.8	6.8

Table 8: Regulated and unregulated CO_2 emissions for the development

	Reduction in Regulated Carbon Dioxide emissions	
	(Tonnes CO_2 per annum)	(%)
Be Lean + Be Clean + Be Green	3.3	36.0%
Min. Target Savings	3.2	35.0%
Shortfall	-0.1	-1.0%

Table 9: Regulated carbon dioxide savings from Be Lean, Be Clean and Be Green measures

8. CARBON OFFSETTING

8.1 Residential Element

Carbon off-setting must be implemented for the residential element of the scheme to achieve the 'zero carbon' target of the London Plan. Table 10 shows that an annual saving of 5.8 tonnes CO2 is required, which over 30 years is equivalent to 175 tonnes. At £60 per tonne this is equivalent to a payment of £10,518.

	Regulated Carbon Dioxide emissions	
	(Tonnes CO_2 per annum)	(%)
Savings from energy demand reduction (Be Lean)	-0.5	-5.6%
Savings from CHP (Be Clean)	0.0	0.0%
Savings from renewable energy (Be Green)	3.8	41.6%
Cumulative on site savings	**3.3**	**36.0%**
Annual Savings from off-set Payment	5.8	-
Cumulative savings for off-set payment	175	
Off-Set Payment (£60 per tonne)	£10,518	

Table 10: Cumulative carbon savings, and carbon off-setting requirements

9. CONCLUSION – CO_2 REDUCTION

The 35% minimum carbon reduction target is achieved by the combination of "Be Lean", "Be Clean" and "Be Green" measures, as summarised in Figure 4 below, with a small surplus.

"Be Lean" measures were unable to achieve any carbon reduction because of conservative assumptions for thermal bridging, despite having a high fabric standard and air tightness. This will be addressed at a later stage.

No savings were achieved in the "Be Clean" stage of the energy hierarchy, since no district heating system is available for the site, and an on-site CHP would not be suitable for the site.

To achieve the "zero-carbon" target, carbon offsetting is required to the amount of 175 tonnes, equivalent to a £10,518 offset payment.

Figure 4: Cumulative CO_2 savings associated with Be Lean, Be Clean and Be Green measures

10. OVERHEATING & COOLING

10.1 SAP Overheating Risk Assessment

Details of the overheating risk assessment can be found in “Appendix 8: SAP Overheating Risk Assessment”. As shown, based on the extent of the glazing, window openings and solar gains, the SAP calculator shows a “Slight” risk of overheating.

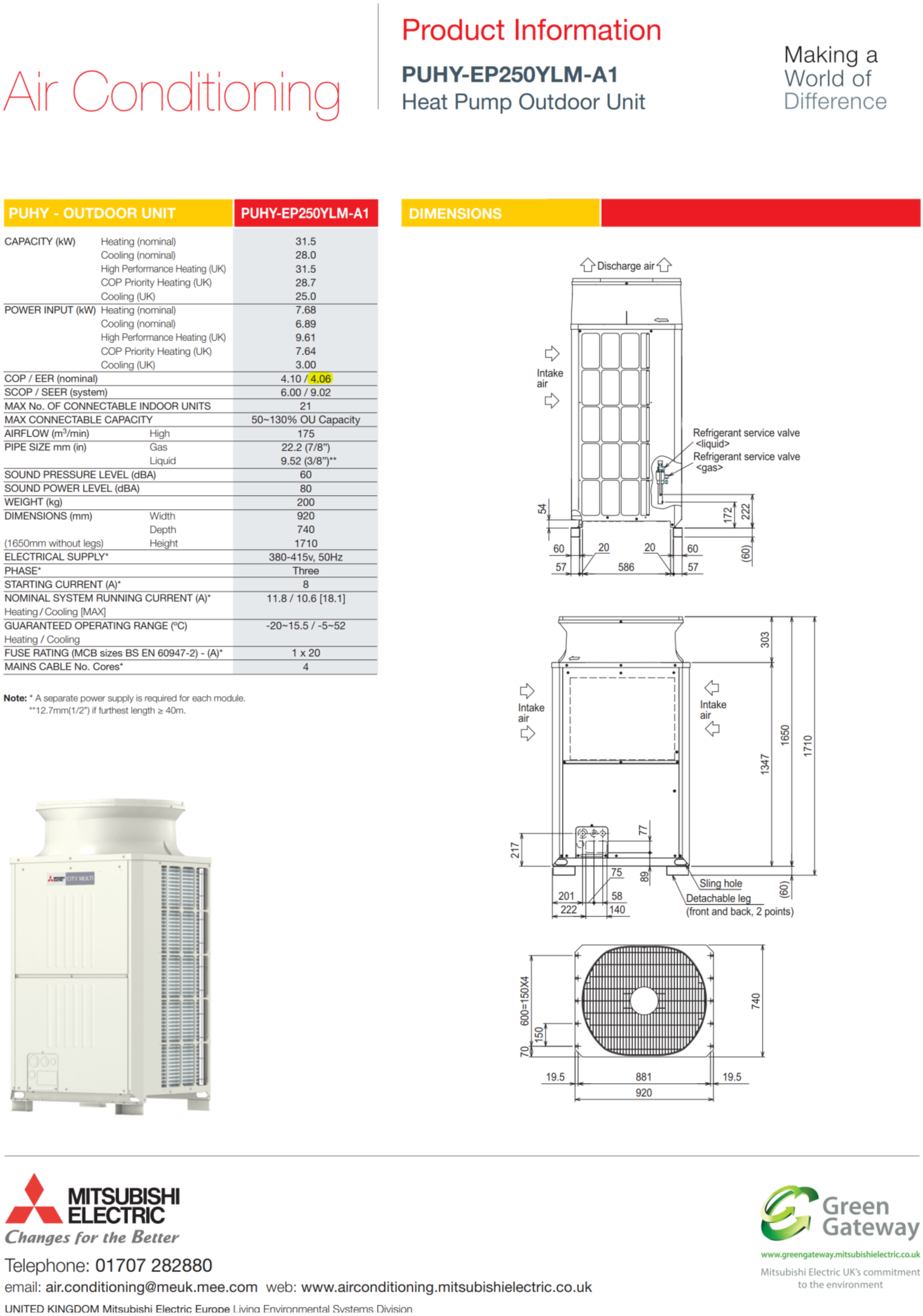
10.2 Comfort Cooling Provision

To provide a high quality internal environment to the replacement dwelling, two important factors must be taken into account: 1 – the overheating risk assessment results; 2 - numerous openable windows on multiple facades increase the potential for external noise intrusion, unwelcome particulate matter, pollen and other external contaminants, reduced security and increase the risk of crime. The installation of equipment for active cooling is therefore an applicant choice for certainty, comfort conditions and security throughout warm summer weather. However, the building has been designed/optimised to reduce the reliance on the cooling system;

- The building is surrounded by existing (and proposed) trees, which provide natural shading in the
- summer months.
- Window openings will be optimised to provide good levels of natural ventilation throughout
- occupied areas. Where possible, cross ventilation will be provided.
- Mechanical ventilation units will be equipped with summer bypass, and summer boost mode, to
- provide additional fresh air into the building.
- Solar control glass will be considered on southern elevations, although this will also impact on the winter energy balance.

10.3 Efficiency of Cooling System

The cooling system has been selected with efficiency as a priority. Figure 5 shows a proposed type of system that would be suitable for the application. The nominal energy efficiency ratio (EER) is over 4, which means that for every four units of cooling provided, one unit of electricity is consumed.



Air Conditioning

Product Information

PUHY-EP250YLM-A1
Heat Pump Outdoor Unit

Making a
World of
Difference

PUHY - OUTDOOR UNIT		PUHY-EP250YLM-A1
CAPACITY (kW)	Heating (nominal)	31.5
	Cooling (nominal)	28.0
	High Performance Heating (UK)	31.5
	COP Priority Heating (UK)	28.7
	Cooling (UK)	25.0
POWER INPUT (kW)	Heating (nominal)	7.68
	Cooling (nominal)	6.89
	High Performance Heating (UK)	9.61
	COP Priority Heating (UK)	7.64
	Cooling (UK)	3.00
COP / EER (nominal)		4.10 / 4.06
SCOP / SEER (system)		6.00 / 9.02
MAX No. OF CONNECTABLE INDOOR UNITS		21
MAX CONNECTABLE CAPACITY		50~130% OU Capacity
AIRFLOW (m^3/min)	High	175
PIPE SIZE mm (in)	Gas	22.2 (7/8")
	Liquid	9.52 (3/8")**
SOUND PRESSURE LEVEL (dBA)		60
SOUND POWER LEVEL (dBA)		80
WEIGHT (kg)		200
DIMENSIONS (mm)	Width	920
	Depth	740
(1650mm without legs)	Height	1710
ELECTRICAL SUPPLY*		380-415v, 50Hz
PHASE*		Three
STARTING CURRENT (A)*		8
NOMINAL SYSTEM RUNNING CURRENT (A)* Heating / Cooling [MAX]		11.8 / 10.6 [18.1]
GUARANTEED OPERATING RANGE (ºC) Heating / Cooling		-20~15.5 / -5~52
FUSE RATING (MCB sizes BS EN 60947-2) - (A)*		1 x 20
MAINS CABLE No. Cores*		4

Note: * A separate power supply is required for each module.
**12.7mm(1/2") if furthest length ≥ 40m.

DIMENSIONS

MITSUBISHI ELECTRIC
Changes for the Better

Telephone: 01707 282880
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Figure 5: Proposed comfort cooling system (subject to detailed design)

11. METERING & MONITORING

11.1 Monitoring

Energy monitoring should be implemented as part of the design for the building systems, including;

- Sub metering of heat use- for hot water and space heating
- Electricity use lighting
- Electricity for small power
- Output from renewable energy systems

12. SUSTAINABILITY

The appointed Contractor will be tasked with seeking to reuse the highest possible percentage of recycled material from the existing building, as far as reasonably practical within the constraints of the design requirements of the new build.

At detail design stage the project team will aim for at least two of the following five construction elements to achieve a Green Guide Rating of A+ to D: roof, external walls, internal walls (including separating walls); upper and ground floors; windows.

13. APPENDIX 2: PRELIMINARY APPRAISAL OF RENEWABLE ENERGY OPTIONS

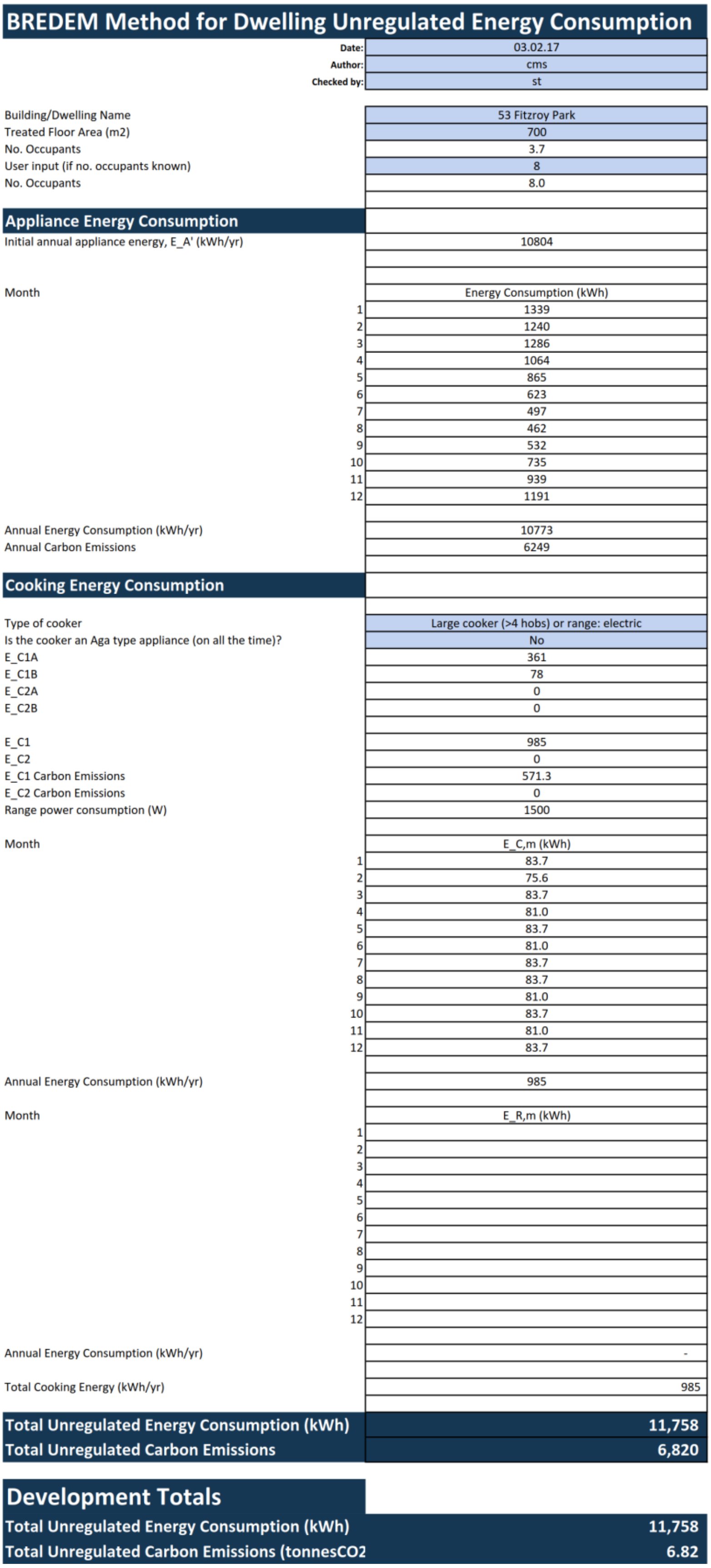
Table 11 summarises the preliminary analysis of renewable energy options, and identifies which should be assessed in further detail, and which should be discounted because of clear technical reasons or other obstacles.

LZC technology	Basic Technical Information	Technical, Environmental and Economic implications/considerations	Suited Application	Site specific comment	Consider Further?
Solar thermal	Solar collectors (flat plate or tube) transfer energy into transfer liquid to a closed loop twin coil hot water cylinder	+ Government grants available (RHIs) +/- Can meet a significant proportion of the DHW demand - Efficiency effected by site factors – shading, orientation and roof/ground space -Requires considerable hot water demand all year round to be finically beneficial	Domestic and commercial applications with high annual hot water load; leisure centres, canteens, washrooms	Solar thermal is suitable for the site, but would typically only contribute around 50-60% of hot water requirements. The system would compete for space with the solar PV system. Overall, carbon emissions reduction is likely to be small.	Yes
Wind turbine	Turbine/generator converts wind energy to electrical power.	+ Government grants available (FITs) + Allows on site generation of renewable electricity - Can create structural, vibrations and noise implications - Not suited for urban environments - Costs can be high in relation to the actual amount of electricity generated - Potential for additional planning issues	Large sized turbines in non-urban or offshore locations will be more effective	The site is located in a dense urban area and further planning approvals would be required.	No
Solar Photovoltaic	Converts sunlight to DC electrical power which then using an inverter to convert to DC.	+ Government grants available (FITs) + Allows on site generation of renewable electricity + Generally payback between 7-12 years + Low maintenance requirements - Efficiency effected by site factors – shading, orientation and roof/ground space	Wide range of building types particularly buildings with limited solar shading and south facing roof	There is sufficient roof space with no obvious issues of over shading. Further investigation is required.	Yes
Air source heat pump	Air Source Heat Pumps (ASHP) capture heat from the outside air and transfer the heat directly to the air inside the building or transferring the heat to a liquid medium that can be pumped around the building	+Lower installation cost that ground source heat pump + Can provide heating and cooling + Government grants available (RHIs) -COP is not as good during the heating season when the outside air temperature is often less than the ground temperature -Can restrict distribution strategies -Carbon saving are less clear cut	Wide range of building types particularly building designed to have low temperature heat emitters.	Domestic ASHPs offer high efficiencies and can provide a modest reduction in carbon emissions. However, the performance must be checked carefully, and the design must be implemented to maximise system efficiency.	Yes
Ground source heat pump	Ground Source Heat Pumps (GSHP) capture heat from the ground and transfer the heat to a liquid medium that can be pumped around the building	+ COP is much better than air source heat pumps + Government grants available (RHIs) -Requires area for ground collector or borehole -High initial capital cost - Can restrict distribution strategies -Carbon saving are less clear cut	Suits building designed to have low temperature heat emitters with sufficient space for necessary ground works	Insufficient external space to allow for the installation	No
Biomass	Uses biomass as a fuel source for space heating and hot water	+ Government grants available (RHIs) + Renewable source of heating - Requires large fuel storage capacity - Generally a large capital cost	Building/site with sufficient access and storage facilities and a capable maintenance team	There is insufficient storage space and very limited access for regular deliveries to warrant further investigation.	No

Table 11: Initial review of Low or Zero Carbon Technologies

14. APPENDIX 3: SUPPORTING SAP DOCUMENTATION

15. APPENDIX 6: SUPPORTING BREDEM CALCULATION



BREDEM Method for Dwelling Unregulated Energy Consumption

Date:	03.02.17
Author:	cms
Checked by:	st

Building/Dwelling Name	53 Fitzroy Park
Treated Floor Area (m2)	700
No. Occupants	3.7
User input (if no. occupants known)	8
No. Occupants	8.0

Appliance Energy Consumption

Initial annual appliance energy, E_A' (kWh/yr)	10804
Month	Energy Consumption (kWh)
1	1339
2	1240
3	1286
4	1064
5	865
6	623
7	497
8	462
9	532
10	735
11	939
12	1191
Annual Energy Consumption (kWh/yr)	10773
Annual Carbon Emissions	6249

Cooking Energy Consumption

Type of cooker	Large cooker (>4 hobs) or range: electric
Is the cooker an Aga type appliance (on all the time)?	No
E_C1A	361
E_C1B	78
E_C2A	0
E_C2B	0
E_C1	985
E_C2	0
E_C1 Carbon Emissions	571.3
E_C2 Carbon Emissions	0
Range power consumption (W)	1500
Month	E_C,m (kWh)
1	83.7
2	75.6
3	83.7
4	81.0
5	83.7
6	81.0
7	83.7
8	83.7
9	81.0
10	83.7
11	81.0
12	83.7
Annual Energy Consumption (kWh/yr)	985
Month	E_R,m (kWh)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
Annual Energy Consumption (kWh/yr)	-
Total Cooking Energy (kWh/yr)	985

Total Unregulated Energy Consumption (kWh)	**11,758**
Total Unregulated Carbon Emissions	**6,820**

Development Totals

Total Unregulated Energy Consumption (kWh)	**11,758**
Total Unregulated Carbon Emissions (tonnesCO2	**6.82**

16. APPENDIX 7: SUMMARY OF CARBON EMISSIONS CALCULATION

No.	Dwelling	Floor Area (m^2)	Baseline (kgC02/yr)	Be Lean (kgC02/yr)	Be Lean, Be Clean (kgC02/yr)	Be Lean, Be Clean, Be Green (kgC02/yr)
1	53 Fitzroy Park	700	9132.81	9646.53	9646.53	5843.4
	Total (kgC02/yr)		9132.81	9646.53	9646.53	5843.4
	Total (tonnes C02/yr)		9.1	9.6	9.6	5.8
	C02 reductions compared to Baseline (%)		0	-5.6%	-5.6%	36.0%
	C02 reductions compared to previous stage (%)		0	-5.6%	0	41.6%

17. APPENDIX 8: SAP OVERHEATING RISK ASSESSMENT

SAP 2012 Overheating Assessment

Calculated by Stroma FSAP 2012 program, produced and printed on 03 February 2017

Property Details: Boiler + PV Efficiency

Dwelling type:	Detached House
Located in:	England
Region:	South East England
Cross ventilation possible:	No
Number of storeys:	3
Front of dwelling faces:	South East
Overshading:	Average or unknown
Overhangs:	None
Thermal mass parameter:	Indicative Value Medium
Night ventilation:	False
Blinds, curtains, shutters:	Light-coloured curtain or roller blind
Ventilation rate during hot weather (ach):	2.5 (Windows open half the time)

Overheating Details:

Summer ventilation heat loss coefficient:	1845.44	**(P1)**
Transmission heat loss coefficient:	485.7	
Summer heat loss coefficient:	2331.1	**(P2)**

Overhangs:

Orientation:	**Ratio:**	**Z_overhangs:**
South East (SE LG Window)	0	1
South East (SE GF Window)	0	1
North East (NE LG Window)	0	1
North East (NE GF Window)	0	1
North East (NE 01 Window)	0	1
North West (NW LG Window)	0	1
North West (NW GF Window)	0	1
North West (NW 01 Window)	0	1
South West (SW LG Window)	0	1
South West (SW GF Window)	0	1
South West (SW 01 Window)	0	1
South East (SE 01 Window)	0	1
Horizontal (Rooflight)	0	1

Solar shading:

Orientation:	**Z blinds:**	**Solar access:**	**Overhangs:**	**Z summer:**	
South East (SE LG Window)	0.6	0.9	1	0.54	**(P8)**
South East (SE GF Window)	0.6	0.9	1	0.54	**(P8)**
North East (NE LG Window)	1	0.9	1	0.9	**(P8)**
North East (NE GF Window)	1	0.9	1	0.9	**(P8)**
North East (NE 01 Window)	1	0.9	1	0.9	**(P8)**
North West (NW LG Window)	0.6	0.9	1	0.54	**(P8)**
North West (NW GF Window)	0.6	0.9	1	0.54	**(P8)**
North West (NW 01 Window)	0.6	0.9	1	0.54	**(P8)**
South West (SW LG Window)	0.6	0.9	1	0.54	**(P8)**
South West (SW GF Window)	0.6	0.9	1	0.54	**(P8)**
South West (SW 01 Window)	0.6	0.9	1	0.54	**(P8)**
South East (SE 01 Window)	0.6	0.9	1	0.54	**(P8)**
Horizontal (Rooflight)	1	1	1	1	**(P8)**

Solar gains:

Orientation	**Area**	**Flux**	**g_**	**FF**	**Shading**	**Gains**

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South East (SE LG Window	0.9 x	3.17	126.97	0.6	0.8	0.54	93.9	
South East (SE GF Window	0.9 x	13.58	126.97	0.6	0.8	0.54	402.24	
North East (NE LG Window	0.9 x	1.46	105.45	0.6	0.8	0.9	59.86	
North East (NE GF Window	0.9 x	11.47	105.45	0.6	0.8	0.9	470.26	
North East (NE 01 Window	0.9 x	2.86	105.45	0.6	0.8	0.9	117.26	
North West (NW LG Window)	0.9 x	8.22	105.45	0.6	0.8	0.54	202.21	
North West (NW GF Window)	0.9 x	8.18	105.45	0.6	0.8	0.54	201.23	
North West (NW 01 Window)	0.9 x	1	105.45	0.6	0.8	0.54	24.6	
South West (SW LG Window)	0.9 x	25.74	126.97	0.6	0.8	0.54	762.42	
South West (SW GF Window)	0.9 x	37.75	126.97	0.6	0.8	0.54	1118.15	
South West (SW 01 Window)	0.9 x	21.73	126.97	0.6	0.8	0.54	643.64	
South East (SE 01 Window	0.9 x	0.63	126.97	0.6	0.8	0.54	18.66	
	1 x	14.48	216	0.76	0.7	1	1497.53	
						Total	5611.96	**(P3/P4**

Internal gains:

	June	July	August	
Internal gains	1181.57	1131.62	1146.4	
Total summer gains	7137.69	6743.58	6075.49	**(P5)**
Summer gain/loss ratio	3.06	2.89	2.61	**(P6)**
Mean summer external temperature (South East England)	15.4	17.4	17.5	
Thermal mass temperature increment	0.25	0.25	0.25	
Threshold temperature	18.71	20.54	20.36	**(P7)**
Likelihood of high internal temperature	**Not significant**	**Slight**	**Not significant**	

Assessment of likelihood of high internal temperature: <u>Slight</u>