Intended for
Dexter Moren Associates

On behalf of
West London Mission

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Project Number
UK11-20679

METHODIST CHURCH AND RESIDENTIAL ACCOMMODATION, 58A BIRKENHEAD STREET, KINGS CROSS, LONDON
ENERGY STATEMENT

RAMBOLL ENVIRON

ENERGY STATEMENT

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EXECUTIVE SUMMARY

This Report has been prepared to set down the results of the energy analysis and the resulting energy strategy in support of the planning application for the new King Cross Methodist Church and residential development at 58A Birkenhead Street, Kings Cross, London.

An Energy Assessment and a Statement of the intended Energy Strategy is a requirement of the planning authority and one of the considerations in the approval process. The assessment has to follow the principles set out by the Energy hierarchy of:

- Be Lean – minimise energy demand
- Be Clean – use energy efficiently
- Be Green – use renewable energy where feasible

The Energy Strategy will be judged by the planning authority against target reductions in CO_2 emissions set by the Greater London Authority and the London Borough of Camden. The targets are expressed in terms of the improvement on 2013 Building Regulations TER for Domestic and Non Domestic buildings and are:

- Greater London Authority – 35% for Domestic and Non domestic buildings
- Greater London Authority and the London Borough of Camden – achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible

The target set by the London Plan and the Local Development Framework for the London Borough of Camden is to achieve an improvement of 35% over the target emission rate set by 2013 Building Regulations; incorporate CHP from a district heating network or on site and to achieve a 20% reduction in carbon emissions through the use of renewable energy technologies.

Being Lean

The assessment has determined that there is limited opportunity to improve upon the Building Regulation minimum specifications and as a result CO_2 reductions are relatively modest at 4.3% of the 2013 target emission rate for regulated energy use on the site.

Being Clean

Enquiries have been made with the local district heating network provider and a connection to this development is not considered financially viable.

The assessment of an onsite solution has concluded that a CHP on site providing heating and hot water to the Church and associated accommodation is predicted to achieve a 19% reduction in the carbon emissions from the regulated energy use on the site. This outperformed the alternative air source heat pump option and has been included in the strategy for the site.

The inclusion of the flats on the CHP network has been discounted as it is considered that this is not viable for a private residential scheme of this size.

Being Green

The analysis showed that Exhaust Air Heat Pumps providing heating and hot water in the private residential flats is predicted to achieve a reduction in CO_2 emissions of 35% relative to the target emission determined by Building Regulations Part L1A 2013 for domestic accommodation.

The assessment predicted that the addition of Photovoltaic panels for electricity generation on the roof contributed a further 4.0% carbon reduction.

The overall reduction in carbon emissions derived from exhaust air heat pump in the flats and the photovoltaic panels is predicted to be 9.4% when related to Building Regulations Part L target emission rate for the development.

Table 1 below sets out the predicted carbon emissions and reductions resulting from the energy strategy set out above. The table is formatted to comply with the requirements of the GLA in their guidance on preparing energy assessments.

	Carbon Dioxide Emissions (Tonnes CO2 per annmum)						
	Regulated						Unregulated
	Non-Domestic Church and associated accommodation		**Domestic** Wardens and Leasehold flats		**Total Development**		**Total Development**
	CHP and PV		**EAHP/ASHP**				
Table 1 Carbon Dioxide Emissions after each stage of the Energy Hierarchy							
Baseline Part L 2013 of the Building Regulations Compliant Development	90.41		17.06		107.47		50
Be Lean after energy demand reduction	86.51		16.50		103.01		50
Be Clean - after CHP	66.04		16.5		82.54		50
Be Green - after renewable energy	62.39		10.42		72.81		50
Table 2 Regulated Carbon Dioxide savings from each stage of the energy hierarchy							
	Tonnes CO2 per annum	%	Tonnes CO2 per annum	%	Tonnes CO2 per annum	%	
Savings from energy demand reduction	3.90	4.55%	0.56	3.28%	4.46	4.34%	
Savings from CHP	20.47	22.64%	0.00	0.00%	20.47	19.91%	
Savings from renewable energy	3.66	4.04%	6.08	35.64%	9.74	9.47%	
Total Cumulative Savings	28.03	31.00%	6.64	38.92%	34.67	33.71%	
Table 3 Shortfall in regulated carbon dioxide savings							
Total Target Savings	31.64	35.00%	5.97	35.00%	37.62	35.00%	
Annual Surplus	-3.62		0.67		-2.95		

Table 1 - Carbon dioxide savings resulting from the conclusions of the energy assessment

The assessment has been carried out in accordance with the principles of the Energy Hierarchy and it has been concluded that the energy strategy for the site to achieve the optimum reduction in carbon emissions is:

Be Lean – thermal improvements to the building envelope, optimise system performance and incorporate 100% LED lighting.

Be Clean – incorporate Combined Heat and Power for heating and hot water generation in the Church and associated accommodation.

Be Green – incorporate exhaust air heat pumps in the Domestic flats for heating and domestic hot water generation and photovoltaic panels for electricity generation.

The reduction in carbon emissions resulting from this strategy is predicted to be 34 Tonnes of carbon dioxide equivalent to a 33% reduction in the carbon emissions target set by Part L 2013 of the Building Regulations. Combined heat and power has been incorporated into the development together with renewable energy technologies, which are predicted to reduce regulated carbon emissions on the site by 20 Tonnes (19%) and 9 Tonnes (9%) respectively.

The assessment has predicted that the development will not meet the targets for CO_2 reduction set by the planning authorities but the energy strategy that has been adopted is shown to be the optimum for maximising carbon reduction on the site.

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1. INTRODUCTION

1.1 Development Description

The Proposed Development comprises a new build Methodist Church and associated accommodation together with 11 leasehold flats on the site of the existing Methodist Church and accommodation which is to be demolished. The scheme is arranged over basement, ground plus four floors and comprises 2,400m2 of accommodation for the church and associated charity and 850m2 of leasehold flats.

An overview of the accommodation and the mechanical and electrical services is given in Section 3 of this report.

1.2 Energy Assessment Procedure

The assessment process which has been followed is commonly known as Being Lean, Being Clean and Being Green where:

- Being Lean minimises the energy consumption of the building through fabric and plant optimisation;
- Being Clean is introducing building services that produces on-site energy rather than importing from the grid and
- Being Green is introducing technologies that require no or a small quantity of grid energy to reduce the overall CO2 emissions from on-site activities.

The predicted Energy consumption and associated CO_2 emissions have been calculated using SAP 2013 software for the Domestic accommodation comprising the leasehold and Warden's flats. The remaining Non-Domestic accommodation has been analysed using iSBEM 2013 software.

This report sets out the results of the assessment and the intended energy strategy that responds to these targets and employs mechanical and electrical solutions that are both economical and practically feasible.

2. PLANNING POLICY BACKGROUND

2.1 National Policy

The Energy White Paper, published in 2003, sets out the UK target of producing 10% of UK electricity from renewable energy by 2010 and the aspiration of doubling this by 2020. This is within the context of the UK carbon dioxide target and the goal of putting the UK on a path to cut carbon dioxide emissions by some 60% by 2050. 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.

The Government Planning Guidance allows and encourages local planning authorities to set out clear policy requirements for on-site renewable energy generation in major development proposals.

2.2 Regional Policy – GLA London Plan March 2015

The London Plan prepared by the Greater London Authority sets out in Chapter 5 London's Response to Climate Change and sets down a number of policies to be followed by major developments in the capital to achieve the Mayors goals of reducing carbon dioxide emissions and conserving resources.

Policy 5.1. Climate Change Mitigation, requires London Boroughs to put in place policies that are consistent with the mayor's goal of working towards a 60 per cent reduction relative to the 1990 level by 2025.

Policy 5.2 Minimising Carbon Emissions, requires that proposals for major developments should include a detailed energy assessment demonstrating how the targets for reduction in carbon dioxide emissions will be met following the now familiar energy hierarchy of:

Be Lean- use less energy

Be Clean – supply energy efficiently

Be Green – use renewable energy

The targets set down for reductions in carbon dioxide emissions have been amended in April 2014 by Supplementary Planning Guidance "Sustainable Design and Construction". The targets set by the London Plan which are expressed in terms of the improvement on 2010 Building Regulations target emission rates (TER) for Domestic and Non-domestic buildings are as follows :

Year	Domestic/Residential	Non- Domestic
2013 – 2016	40 per cent	40 per cent
2013 - 2019	Zero carbon	Building Regulations
2019-2031		Zero carbon

The SPG recognises that the Building Regulations of 2013 specified measures that would achieve a reduction in carbon emissions when compared to the 2010 Building Regulations of 6% in residential buildings and 9% in Non Domestic buildings. This was lower than anticipated by the London Plan and as consequence the SPG sets a reduction target of 35 % for both domestic and non-domestic buildings but recognises that this may be difficult to achieve in some developments.

The consideration of Combined Heat and Power is explained further in Policy 5.6 Decentralised Energy in Development Proposals and requires that

"Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.

Major development proposals should select energy systems in accordance with the following hierarchy:

1) Connection to existing heating or cooling networks

2) Site wide CHP network

*3) Communal heating and coo*ling.

The requirement to consider renewable energy in development proposals is set out Policy 5.7 Renewable Energy states that:

"Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible."

Clause 5.42 of the London Plan states:

"Individual development proposals will also help to achieve these targets by applying the energy hierarchy in Policy 5.2. There is a presumption that all major development proposals will seek to reduce carbon dioxide emissions by at least 20 per cent through the use of on-site renewable energy generation wherever feasible.

Development proposals should seek to utilise renewable energy technologies such as: biomass heating; cooling and electricity; renewable energy from waste; photovoltaics; solar water heating; wind and heat pumps.

The Mayor encourages the use of a full range of renewable energy technologies, which should be incorporated wherever site conditions make them feasible and where they contribute to the highest overall and most cost effective carbon dioxide emissions savings for a development proposal."

The GLA has published the "GLA Guidance on preparing energy assessments". This clarifies what energy consumptions should be included in the calculations, and how they are calculated.

The guidance states that the Energy Hierarchy must demonstrate savings in regulated CO_2 emissions compared to a development that complies with the 2010 Building Regulations.

The Guidance defines regulated emissions as the energy consumed in the operation of the space heating / cooling and hot water systems, ventilation and internal lighting. It also defines unregulated emissions as relating to cooking and electrical appliances and other small power.

Non-regulated small power may typically include lifts, infrastructure plant such as cold water and sewage pumps, unregulated ventilation such as that for underground car-parks, and unregulated lighting such as external lighting and underground car-parks.

For the regulated emissions, the GLA Guidance states that a Building CO_2 Emissions Rate (BER) calculated through the Building Regulations 2010 methodology based on the National Calculation Methodology (NCM), implemented through approved software, should be established. For non-regulated emissions, benchmarks from CIBSE Guide F, or others from previous development work should be followed.

2.3 Local Policy – London Borough of Camden

The central part of the Local Development Framework for the Borough of Camden is the "Core Strategy 2010-2025" which sets out the vision and strategy for the borough. Core Strategy 13 sets out the requirements to minimise the effects of climate change and reduce carbon emissions. This outlines a similar approach to minimising energy consumption as the London plan and requires developments to be designed to minimise energy consumption, assess the availability of local energy networks or the potential to generate from low carbon technology. The Council expects that developments *“achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible”*

“Camden Development Policies 2010-2025” is one of the documents making up the Local Development Framework and sets out the detailed planning policies to be used in determining planning applications in the borough. The policy relating to sustainable design and energy in particular is Policy DP22 “Promoting sustainable design and construction”.

2.4 Energy Hierarchy

2.4.1 Summary of Being Lean

In order to reduce the demand of energy on a specific development, there is the potential to enhance the building passive design, these strategies include:

- Improved u-values.
- Improved air tightness.
- Optimised glazing areas.
- Optimising orientation and site layout.
- Natural ventilation and lighting.
- Thermal mass and solar shading.
- Energy efficient lighting.
- Efficient mechanical ventilation with heat recovery.

2.4.2 Summary of Being Clean

Once the demand for energy has been minimised, energy systems can then be selected to generate on-site energy in efficiently. Technologies that can be considered for this are:

- District Heating Networks.
- Combined Heat and Power Systems.
- Combined Cooling Heat and Power Systems.

2.4.3 Summary of Being Green

On site renewable energy technologies should be considered in order to reduce the CO_2 emissions of the site. The renewable technologies often provide energy without the requirement for input energy and therefore provide complete CO_2 savings.

The technologies highlighted by the ‘Renewables Toolkit’ as suitable for London, and therefore qualifying as ‘Renewables’ for London Boroughs are:

- Solar hot water systems
- Biomass Combined Heat and Power
- Biomass heating
- Ground source heating
- Ground source cooling
- Wind turbines

- Photovoltaics

The GLA document ‘Energy Planning – GLA Guidance on preparing energy assessments’ (September 2011) also includes air-source heat pumps as feasible renewable energy source

3. DEVELOPMENT DESCRIPTION

3.1 Development Location

The Proposed Development is located and is on the site of the existing Methodist Church at 58A Birkenhead Street, Kings Cross, London on the south side of the Euston/Pentonville Road and fronts both Birkenhead and Crestfield Street.

Figure 1: Location Map

The site is bounded on both sides by residential buildings of 3 and 4 stories above ground. The site is constrained and does not provide opportunities for exploring alternative orientations and building form to minimise energy consumption.

3.2 Development Overview

The existing church and accommodation are to be demolished to make way for the new development which provides

- a new church and associated accommodation including seminar and meeting rooms and a kitchen,
- subsidised ancillary accommodation on the second, third and fourth floors,
- a wardens flat and
- 11 leasehold flats.

The scheme is arranged over basement, ground plus four floors and comprises 2,400m2 of accommodation for the church and associated hostel and 850m2 of leasehold flats. The building rises to ground plus four floors on the Crestfield Street frontage and ground plus 3 floors on Birkenhead Street. An external light well is arranged in the centre of the development which reaches down to the basement to assist with natural light and fresh air ventilation.

There are 3 lifts serving the church and associated accommodation, the hostel and wardens flat and the leasehold flats.

3.3 Overview of Mechanical Building Services

The Domestic flats will be naturally ventilated with trickle vents in the windows and continuously running extract ventilation in bathrooms, WC's and kitchens. Purge ventilation will be via openable windows.

Wherever possible the Non-Domestic accommodation will be naturally ventilated, although due to high occupancies in a number of the spaces mechanical ventilation with heat recovery (MVHR) will be necessary to meet fresh air requirements for the occupants. MVHR will be necessary for internal occupied spaces to supply and exhaust fresh air.

Heating will be provided to by low temperature hot water underfloor heating

Due to high occupancies in the church, seminar and meeting rooms cooling will be necessary to maintain acceptable temperatures; the cooling will be provided by air source VRF units.

LED lighting will be provided throughout. The flats will be manually switched; the remainder will be a mix of PIR and daylight dimming as appropriate.

4. ASSESSMENT OF ANNUAL ENERGY CONSUMPTION

4.1 Estimating Annual Energy Demand

The predictions of energy demand and CO_2 emissions have been assessed using 2013 Building Regulations Approved Document Parts L1A and L2A compliant software, SAP version 9.92 (NHER Plan assessor version 6.1.2) and SBEM v5.2.d.2 respectively.

This software assesses the regulated energy use and forms the basis for assessing the carbon reductions and compliance with the planning targets. The SAP assessments are for 2 of the flats which are considered representative of the remaining 10. The Wardens flat on the first floor and the leasehold flat R3.32 on the top floor have been selected.

The results of the SAP and SBEM assessment have been summarised in Tables 7 and 8 respectively which together with the SAP and SBEM output documentation for the selected energy strategy are included Appendices 1 and 2 at the end of the report.

4.2 Be Lean – minimising energy demand

4.2.1 Improved U-values

Where feasible the minimum standards set by Building Regulations for the thermal performance of the envelope have been improved upon to enhance the efficiency of the proposed building in order to reduce the CO_2 emissions. The Building Regulations sets minimum thermal performance standards for the building envelope but uses enhanced standards in the assessment of the target emission rate for the building. Although improvements to the minimum standard have been adopted for the development these are not in all cases an improvement on the standard included within the TER assessment.

The three values for the specification of the building envelope are set out in Table 2 below.

			Domestic - Part L1A			Non-Domestic Part L2A		
			Minimum Part L1A standard	TER Notional Building Specification	Kings Cross Methodist Church Residential	Minimum Part L2A standard	TER Notional Building Specification	Kings Cross Methodist Church Non-Domestic
Building Fabric								
	External Wall	W/m^2.K	0.30	0.18	0.18	0.35	0.26	0.18
	Party Wall	W/m^2.K	0.20	0.00	0.18			
	Roof	W/m^2.K	0.20	0.13	0.13	0.25	0.18	0.13
	Floor	W/m^2.K	0.25	0.13	0.13	0.25	0.22	0.10
	External Glazing,roof windows and fully glazed doors	W/m^2.K	2.00	1.40	1.40	2.20	1.60	1.40
		g-value		0.63			0.40	
		Light Transmittance					0.71	
	External opaque Doors	W/m^2.K	2.00	1.00	1.00			1.00
	Semi glazed doors	W/m^2.K		1.20	1.20			1.20
	Thermal bridging		0.15 default value		Approved Construction Details			0.15 default value
	Area of window and door openings			25% of total floor area	25% of total floor area			25%
	Air Tightness Standard	(m^3/(h.m^2))@50Pa	10.00	5.00	4.00	10.00	3.00	3.00
	Thermal mass parameter			Medium (TMP = 250)				

Table 2: Fabric Performance improvements

4.2.2 System Performance

The criteria used in the analysis for the heating, cooling, ventilation and hot water service are set out in Table 3. The criteria used for the efficiency and control of the lighting installation are set out in Table 4. Further design development will be required during the detailed design process.

			Domestic - Part L1A		Non-Domestic Part L2A	
			TER Notional Building Specification	Kings Cross Methodist Church Residential	TER Notional Building Specification	Kings Cross Methodist Church Non-Domestic
Heating and Cooling Systems						
	Heating	Type	Combi-boiler with radiators	Combi gas boiler with underfloor heating		Central gas boiler with underfloor heating
		Efficiency	89.5% (SEDBUK 2009)	89.5% (SEDBUK 2009)	91% for heating and hot water	92% for heating and hot water
		Control	Time and temperature zone control with weather compensation, modulating boiler with interlock	Programmable time control and Room thermostat	variable speed control of pumps	Programmable time control, weather compensation and room thermostats, variable speed pumps
	Secondary heating		None	None	None	None
	Heating Controls					
	Cooling System			na	DX cooling	VRF cooling
	Cooling System Efficiency			na	Mixed Mode SSEER - 2.7	
	BMS Montoring Capabilities			na		DDC control system
Ventilation						
	natural ventilation			all perimeter rooms provided with trickle ventilators and openable windows compliant with Part F		all perimeter rooms provided openable windows compliant with Part F
	mechanical extract ventilation		2 extract fans up to TFA of 70m2, 3 fans for TFA 70m2 to 100m2	continous ventilation to Bathrooms and kitchens		toilets, cycle stores etc - see zoning drawings
	Mechanical supply and extract ventilation with heat recovery	**Type**		na	Recovery efficiency 70% variable speed control via CO2 sensors	fresh air ventilation to high occupancy and internal occupied spaces - see zoning drgs
		Heat Recovery efficiency			70.00%	66.00%
		Control				
	Specific Fan Power	**Central Ventilation**			1.80	na
		Terminal Unit			0.30	0.40
	Control			continous with manual boost		programmable time control with manual boost for purge ventilation
Domestic Hot Water						
	Generator Type & Fuel			From Combi gas boiler		From gas fired boiler plant or air source heat pump
	Generator Efficiency					80%
	Storage Volume			na		500 litres
	Insulation			na		foam
	Distribution Delivery Efficiency			na		75%

		Domestic - Part L1A		Non-Domestic Part L2A	
		TER Notional Building Specification	Kings Cross Methodist Church Residential	TER Notional Building Specification	Kings Cross Methodist Church Non-Domestic
Lighting		100% low energy	100% low energy	60 lumens per circuit watt maintenance factor 0.8	100% low energy
Lighting Controls			manual switching	manual switching and daylight control	PIR (manual on, automatic off) with daylight dimming where appropriate
Electrical					
	Expected Power Factor Correction				0.90
	metering				lighting and power separately metered
	Lighting Warn of Out of Range Values				

Table 3: Lighting Performance and control criteria

In addition the following will be implemented in the Non Domestic Accommodation:

- Lighting will include Separate Metering.
- Lighting will include out of range value monitoring.
- Lighting will include constant illuminance control.
- All perimeter zones will have proportional daylight dimming. Once the lux level of each space is achieved by natural daylight, the lighting will switch off. As the illuminance of the space reduces, the lights will proportionally increase in order to maintain the desired lux level.
- The daylight sensors will be on a time switch and have a parasitic value of 0.1W/m2.
- The automatic controls will be on a time switch and have a parasitic value of 0.1W/m2.

4.2.3 Summary of “Be Lean” Results

The result of adopting the specifications and performance criteria set out above has resulted in a 4.3% reduction in carbon emissions when compared to the Target Emission Rate for both the Domestic and Non-Domestic elements of the development. This is equivalent to 4.5 Tonnes of carbon dioxide annually

4.3 Be Clean - Delivering Energy Efficiently

4.3.1 Introduction

Following the implementation of the energy reduction (‘lean’) measures, the second step in providing a sustainable design is to deliver heating, cooling (if applicable) and power to the development as efficiently as possible.

Efficient energy delivery strategies and methods that have been considered in this assessment are:

- Off-site (district) heating systems.
- Onsite community heating with combined heat & power (CHP).

4.3.2 Off-site district CHP heating networks

There are a number of district heating networks existing and planned in the area that employ CHP to deliver heating energy more efficiently than a conventional gas fired installation on site.

Contact has been made with Brookfield Metropolitan who own and operate the local district heating network to determine the viability of connecting the development. There are currently no plans to extend the network south of Euston Road and the development heating load is too small to make a connection financially feasible.

4.3.3 On site CHP heat generation

An onsite community heating installation with CHP could potentially achieve significant CO2 reductions.

A combined heat and power (CHP) system generates electricity as well as heat (in the form of hot water) from a single piece of plant. A CHP plant consists of an 'engine' which runs on fuels such as natural gas, driving an alternator to generate electricity. Heat produced by the engine and exhaust system is typically utilised for buildings' heating systems. The efficiency of the system and the economic viability of the scheme rely on achieving long periods of full load operation and as far as possible coincident demand for heat and electricity.

The CHP installation could be employed to meet the heating and hot water load of the development or just the Non Domestic church and associated accommodation. Both scenarios have been considered.

In order to use the CHP to supply heat to the flats there would need to be a common heating network which would require heat interface units, heat metering and a billing system together with the ongoing management of the revenue costs, billing of the residents and dealing with payment defaults. For the 11 leasehold flats on the development the infrastructure costs and the ongoing revenue costs will impose a burden on the Church which they will have neither the expertise nor the resources to manage.

There are also the issues of the standing losses for the heating distribution network which has to run 24/7 and the resulting overheating of corridors and service cupboards. Neither are insurmountable but do require additional costs in the design specification and operation of the system.

4.3.4 Summary of the "Be Clean" Results

The implementation of a common heating network for the site and the inclusion of CHP are predicted to result in a 23% carbon reduction over and above the Lean measures equivalent to 23.8 Tonnes of carbon dioxide annually. The prediction for the Church and associated accommodation is a 22% carbon reduction equivalent to 20.4 Tonnes annually.

4.4 Be Green - Renewable Technologies

4.4.1 Introduction

Once all suitable energy reduction and efficiency techniques have been considered, renewable energy technologies are assessed in order to further reduce the CO_2 emissions of the development where practical. The following are the technologies that are accepted as renewable and are to be considered in the assessment:

- Solar thermal hot water systems.
- Biomass heating.
- Photovoltaics (PVs).
- Wind turbines.
- Ground source heat pump.
- Air source heat pump.

The constraints of the site limit the size and capacity of each of the technologies and hence the potential to reduce carbon emissions on this development varies with each technology. Biomass boilers or air source heat pumps for heating and hot water could deliver all or the majority of the demand and achieve a high carbon reduction whereas solar thermal hot water, photovoltaics, wind turbines and ground source heat pumps are physically limited by the site and could not deliver equivalent reductions.

The following qualitative assessment considers each of the technologies and their suitability for the development.

4.4.2 Air Source Heat Pumps

Air Source Heat Pump (ASHP) systems use a refrigeration cycle in reverse, to extract low-grade heat from the outside air, and transfer it into useful heat at a higher temperature, for use with space heating systems, and to generate domestic hot water.

ASHP system is technically suited to the Proposed Development, for the following reasons:

- This system is practical for heating systems that are of a low temperature nature .i.e. underfloor heating.
- This technology is relatively robust and low maintenance.
- The technology can be screened or incorporated on the roof ensuring that there is limited visual impact.
- As the technology is electrically driven, there is no on-site pollution impact.
- ASHP system can also work in reverse cycle to provide cooling, which will be a benefit to the Non-domestic element of the scheme.
- The heat pump can be arranged to provide heating and cooling to different zones simultaneously, transferring heat from cooling zones to heating zones thereby improving efficiency

The results of a quantitative assessment predict that exhaust air heat pumps in the flats and VRF heat pumps in the church and associated accommodation will reduce carbon emissions by 35% and 17 % respectively over and above the reduction from the Lean measures.

The target reductions in the carbon emissions for the flats are therefore met by this technology; further reductions are required to the remainder of the development.

4.4.3 Bio-mass Heating Boilers

Biomass is the term used to describe a range of solid fuels from wood (chips, pellets or logs), straw and other waste materials. While carbon may be produced when biomass is burnt, it is considered to be almost carbon neutral as the carbon dioxide produced is offset by the carbon dioxide absorbed by the trees or crops when they were grown.

A biomass boiler may be technically suited to the Proposed Development, due to the year-round base heat load from domestic hot water but a number of factors make this an inappropriate solution for this development:

- Space and access to site for fuel storage and delivery.
- Biomass wood chip or pellet installations contribute to air quality problems in urban environments, in particular NOx and particulate emissions.
- Taller flues will be required than for equivalent gas boilers, which will be an issue where plant is located at basement level.
- On-going maintenance is generally high when compared to other heat generating equipment.
- Natural gas boilers will be required to act as standby for the periods when the biomass boiler is being serviced.
- Biomass boilers have difficulty responding to varying load particularly the lows and highs created by hot water demand. As a consequence thermal storage will be required to even out the load

For these reasons a biomass boiler has been discounted in favour of the air source heat pump

4.4.4 Ground Source Heat Pumps

Ground Source Heat Pump (GSHP) technologies involve the use of underground water sources (aquifers) which retain a near constant temperature all year round, hence in winter the underground water is warmer than the surface air temperatures, and in summer it is cooler. This temperature difference can be used in combination with a heat pump to provide heating and cooling energy.

In order for the technology to work effectively, the ground conditions are required to provide adequate thermal transfer. The constrained plan area of the site does not allow either an open loop or horizontal mat to be used to extract and reject heat. This leaves closed loop vertical piles as the only option.

Extensive site investigations will be necessary to determine whether the local geological conditions are suitable and if there are any obstructions to the pile locations bearing in mind the piles are likely to be in the order of 100m deep.

A ground source heat pump installation is very expensive and installations on small sites such as this do not achieve high carbon reductions when compared to other technologies such as air source heat pumps and biomass boilers.

For these reasons a ground source heat pump has been rejected in favour of the air source solution.

4.4.5 Solar Thermal Hot Water

Solar Thermal Hot Water systems are a well-established renewable energy source to provide hot water for domestic use.

Solar thermal systems in the UK normally operate with a backup source of heat, such as gas or electricity. Due to the variable and unpredictable demand for hot water there would need to be significant thermal storage to collect heat when it is available in readiness for its use when the demand arises.

Solar thermal has been considered for the church and associated accommodation to meet the hot water demand in combination with the air source heat pump. The results predict that the solar thermal will contribute a further 1% reduction in carbon emissions.

4.4.6 Photovoltaics

Photovoltaic (PVs) systems convert energy from the sun into electricity through semi-conductor cells. PVs can supply electricity to the building they are installed on, or to any other load connected to the electricity grid.

Energy can still be produced in overcast or cloudy conditions, so PVs can be used successfully in all parts of the UK, especially in South England.

If installed by a registered installer in accordance with the regulations the installation can benefit from the feed in tariff for electrical generation.

The installation is relatively simple and does not take up large areas of space within the building in comparison with other technologies

Photovoltaic electricity generation is complementary to the heat generating solutions and does not replace or reduce the capacity of the other technologies. The only competing technology is solar thermal due to the conflict for space on the roof of the development.

The quantitative analysis predicts that a photovoltaic installation of 10kWp (approx. 65 to 70 m2 of panels) in combination with the CHP or the air source heat pump would reduce the carbon emissions of the Church and associated accommodation by a further 4% equivalent to 3.5 Tonnes of Carbon Dioxide.

The area of photovoltaic panel is constrained by the roof area available, which also has to accommodate the requisite area of green roof to meet SUD requirements and air cooled condensers for the VRF cooling of the church and other high occupancy areas.

4.4.7 Wind Turbines

Recorded data identifies the UK is the windiest country in Europe, and as such wind power is one of the UK's most promising renewable energy technologies, and already provides electricity for nearly a quarter of million homes. Wind turbines are a technically proven technology using aerodynamic forces ('lift' and 'drag') to produce mechanical power that can then be converted to electricity.

In urban areas, wind is characterised by increased turbulence which reduces the efficiency of wind turbines which are to these variations.

Wind turbines are known to produce very low and unreliable outputs when mounted in urban environments and have been discounted from this assessment.

4.4.8 Summary of Be Green Results

The annual energy demand and carbon emissions have been assessed for air source heat pumps, solar thermal and photovoltaics in a number of combinations. The results have been tabled in Appendices 1 and 2

The quantitative assessment predicts that exhaust air heat pumps in the flats will achieve the target reduction of 35% and the 20% contribution from a renewable technology for this particular element of the scheme.

The energy consumption of the church and associated accommodation is the dominant factor on the scheme and requires a combination of technologies in order to optimise the carbon reduction for the development.

Of the renewable technologies the air source heat pump achieves the greatest reduction in carbon at 12.5% equivalent to 11.5 Tonnes.

The solar thermal and photovoltaic panels compete for roof space but either individually or in combination can contribute to the carbon reduction for the Non-Domestic accommodation.

The conclusions of the assessment are discussed further in section 4.4.10.

4.4.9 Non-regulated Energy Uses

The target criteria set by the planning authorities is referenced to the carbon emissions from regulated energy use. The assessment is not required and does not include unregulated energy use such as electrical appliances, process equipment, and external infrastructure.

For the purposes of giving a full account of the energy use on the site an assessment has been made of the non-regulated use on the site.

Energy consumption arising from unregulated use is assessed using guidance such as CIBSE Guides, BREDEM and manufacturers data.

The following uses are unregulated:-

- Small power
- Cooking.
- Passenger Lifts (3No). CIBSE Guide D – Transportation Systems in Buildings (2005)
- Cold water booster pumps.
- External Lighting to the Light Well and Cycle Stores.

The results of this assessment are summarised in Table 4 below.

	Electricity kWhr/annum	Natural Gas kWhr/annum
Small Power		
Flats	30,000	
Hostel	18,200	
Church	4,000	
Office, Meeting rooms etc.	16,000	
Total	68,200	
Catering		
Flats	2,182	
Hostel	600	780
Church	9,824	8,496
Total	12,606	9,276
External Lighting	3,500	
Lifts	4,500	
Cold Water Boosting Equipment	750	
Development Total kWhr/annum	89,556	18,552
Development Total Tonnes CO2 /annum	46	4

Table 4 – Assessed Unregulated Energy Use for the development.

In order to minimise the unregulated energy use, high efficiency catering equipment will be specified, high efficiency lighting will be employed externally and lifts will be specified with LED lighting, standby mode in off peak periods and variable speed drives.

4.4.10 Summary of the results of the assessment

A summary of the results of the SAP and SBEM assessments together with the output documentation for the selected energy strategy are included in Appendices 1 and 2 at the end of this report.

Improvements to the thermal performance of the building envelope have been assessed and are incorporated into each of the subsequent assessments of low and zero carbon technologies. The carbon reduction from thermal improvements is predicted to be 4.5 Tonnes which is equivalent to a 4.3% reduction from the 2013 Part L target.

The assessment for the Domestic flats predicts that the maximum carbon reduction can be achieved by an exhaust air heat pump in each flat and that this would satisfy the planning requirement of 35% overall carbon reduction and 20% carbon reduction from renewable technologies related to the 2013 Part L2A target. The CHP option falls short of the 35% target and presents ongoing management issues for the church in the administration of the scheme and has been discounted.

The assessment for the Non-domestic Church and associated accommodation included a number of options to maximise the carbon reduction from a combination of technologies. The technologies that have been considered are combined heat and power, air source heat pump, solar thermal and photovoltaic panels.

The assessment showed the CHP and air source heat pump options are predicted to achieve the largest carbon reduction of the technologies considered but both generate heat and for this reason are competing technologies and are not used together.

The solar thermal generation is also a competing technology to CHP and reduces the run time of the CHP thereby reducing the cost effectiveness of the CHP installation. For this reason solar thermal and CHP are not used together.

In heating mode air source heat pumps are most efficient when the water temperatures are relatively low such as the temperatures employed for underfloor heating. The generation of domestic hot water requires higher temperatures and brings down the efficiency of the heat pump. The combination of air source heat pumps for heating and cooling and solar thermal for hot water generation has been included in the assessment to quantify the benefit.

The generation of electricity by photovoltaic panels on the roof does not compete with any of the other technologies and has been considered in combination with both the CHP and the air source heat pump.

A summary of the SBEM results for the Non-Domestic church and associated accommodation is set out in Appendix 1; the predicted carbon reduction in Tonnes for each of the combinations considered is set out in Table 5 below.

	Carbon Reduction tonnes/year	%
CHP	24.4	26.95%
CHP + 10kWp PV	28.0	31.00%
Air Source Heat Pump for heating cooling and Hot Water (ASHP)	14.6	17.05%
ASHP + PV (10kWp = 70m2)	18.5	21.59%

ASHP for heating and cooling + Solar Hot Water for Hot Water (30m2)	16.1	18.75%
LEAN + ASHP (heating and cooling) + Solar (hot water) + PV (35m2 = 5kWp)	17.5	20.45%

Table 5 - Summary of the regulated carbon reduction assessment for the Church and associated accommodation

All the above are inclusive of the carbon reduction resulting from the improvements to the thermal performance of the building envelope.

As can be seen the combination of thermal CHP and Photovoltaic panels achieves the largest carbon reduction emissions of the technologies considered. The overall reduction is 31% of the 2013 Part L2A target of which 4% is contributed by a renewable technology.

As a result of the assessments that have been carried out the optimum energy strategy for the development is to adopt the following:

Be Lean – thermal improvements to the building envelope, optimise system performance and incorporate 100% LED lighting

Be Clean – incorporate Combined Heat and Power for heating and hot water generation in the Church and associated accommodation

Be Green – incorporate exhaust air heat pumps in the Domestic flats and photovoltaic electricity generation

Table 6 below summarises the resulting prediction of the carbon reduction for the development, set out in the format required by the GLA guidance on preparing energy assessment.

	Carbon Dioxide Emissions (Tonnes CO2 per annmum)						
	Regulated						Unregulated
	Non-Domestic Church and associated accommodation		**Domestic** Wardens and Leasehold flats		**Total Development**		**Total Development**
	CHP and PV		**EAHP/ASHP**				
Table 1 Carbon Dioxide Emissions after each stage of the Energy Hierarchy							
Baseline Part L 2013 of the Building Regulations Compliant Development	90.41		17.06		107.47		50
Be Lean after energy demand reduction	86.51		16.50		103.01		50
Be Clean - after CHP	66.04		16.5		82.54		50
Be Green - after renewable energy	62.39		10.42		72.81		50
Table 2 Regulated Carbon Dioxide savings from each stage of the energy hierarchy							
	Tonnes CO2 per annum	%	Tonnes CO2 per annum	%	Tonnes CO2 per annum	%	
Savings from energy demand reduction	3.90	4.55%	0.56	3.28%	4.46	4.34%	
Savings from CHP	20.47	22.64%	0.00	0.00%	20.47	19.91%	
Savings from renewable energy	3.66	4.04%	6.08	35.64%	9.74	9.47%	
Total Cumulative Savings	28.03	31.00%	6.64	38.92%	34.67	33.71%	
Table 3 Shortfall in regulated carbon dioxide savings							
Total Target Savings	31.64	35.00%	5.97	35.00%	37.62	35.00%	
Annual Surplus	-3.62		0.67		-2.95		

Table 6 - Carbon dioxide savings resulting from the conclusions of the energy assessment

5. CONCLUSIONS

The driving factor of the assessment and the conclusions of this report is the need to comply with the carbon reduction targets policies set by the Greater London Authority and the London Borough of Camden in their respective planning policies. The targets are:

- Reduce carbon emissions by 35% below the target emission rate set by Building Regulations 2013;
- Connect to a local CHP network or include CHP on site;
- At least 20% of the regulated development CO2 emissions should be offset by local Renewable or low emission sources.

All the above criteria are caveated by “where feasible”.

The results of the assessment have concluded that the optimum strategy is to implement the following:

Be Lean – thermal improvements to the building envelope, optimise system performance and incorporate 100% LED lighting

Be Clean – incorporate Combined Heat and Power for heating and hot water generation in the Church and associated accommodation

Be Green – incorporate exhaust air heat pumps in the Domestic flats for heating and domestic hot water generation and photovoltaic panels for electricity generation

The reduction in carbon emissions resulting from this strategy is predicted to be 34 Tonnes of carbon dioxide equivalent to a 33% reduction in the regulated carbon emissions target set by Part L 2013 of the Building Regulations. Combined heat and power has been incorporated into the development together with renewable energy technologies, which are predicted to reduce regulated carbon emissions on the site by 20 Tonnes (19%) and 9 Tonnes (9%) respectively.

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APPENDIX 1: RESULTS OF THE SBEM ANALYSIS FOR THE CHURCH AND ASSOCIATED ACCOMMODATION

		kg CO2/m2/annum		kWhrs/m2										Carbon Reduction tonnes/year			
		TER	BER	Heating	Cooling	Auxillary	Lighting	Hot Water	Equipment	Photovoltaic	Wind	CHP	Solar Thermal	TER	BER	Reduction	%
LEAN	Improved building envelope and system performance	37.1	35.5	7.9	5.01	17.18	14.22	71.03	12.4	0	0	0	0	90.4	86.5	3.9	4.31%
CLEAN	Lean + CHP	37.1	27.1	8.34	3.43	17.18	14.22	76.2	12.4	0	0	16.95	0	90.4	66.0	24.4	26.95%
GREEN	LEAN, + CLEAN + 10kWp PV (=70m2)	37.1	25.6	8.34	3.43	17.18	14.22	76.2	12.4	3	0	16.95	0	90.4	62.4	28.0	31.00%
GREEN	LEAN + Air Source Heat Pump for heating cooling and Hot Water (ASHP)	35.2	29.2	3.08	7.96	16.14	14.22	16.32	12.4	0	0	0	0	85.8	71.2	14.6	17.05%
GREEN	LEAN + ASHP + PV (10kWp = 70m2)	35.2	27.6	3.08	7.96	16.14	14.22	16.32	12.4	3	0	0	0	85.8	67.3	18.5	21.59%
GREEN	LEAN + ASHP for heating and cooling + Solar Hot Water for Hot Water (30m2)	35.2	28.6	3.08	7.96	16.14	14.22	15.2	12.4	0	0	0	4.28	85.8	69.7	16.1	18.75%
GREEN	LEAN + ASHP (heating and cooling) + Solar (hot water) + PV (35m2 = 5kWp)	35.2	28	3.08	7.96	16.14	14.22	15.47	12.4	1.5	0	0	3.24	85.8	68.2	17.5	20.45%

Table 7 – Summary of the SBEM results for the Church and associated accommodation

BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

Project name

50 Birkenhead Street, London

As built

Date: Sat Sep 12 11:07:28 2015

Administrative information

Building Details

Address: 50 Birkenhead Street, LONDON,

Certification tool

Calculation engine: SBEM

Calculation engine version: v5.2.d.2

Interface to calculation engine: iSBEM

Interface to calculation engine version: v5.2.d

BRUKL compliance check version: v5.2.d.2

Owner Details

Name: Information not provided by the user

Telephone number: Information not provided by the user

Address: Information not provided by the user, Information not provided by the user, Information not provided by the user

Certifier details

Name: Andrew Ling

Telephone number: 01722 334755

Address: 14 Oldfield Road, SALISBURY, SP1 3GQ

Criterion 1: The calculated CO_2 emission rate for the building should not exceed the target

CO_2 emission rate from the notional building, $kgCO_2/m^2$.annum	37.1
Target CO_2 emission rate (TER), $kgCO_2/m^2$.annum	37.1
Building CO_2 emission rate (BER), $kgCO_2/m^2$.annum	25.6
Are emissions from the building less than or equal to the target?	BER =< TER
Are as built details the same as used in the BER calculations?	Separate submission

Criterion 2: The performance of the building fabric and the building services should achieve reasonable overall standards of energy efficiency

Values not achieving standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.

Building fabric

Element	$U_{a\text{-}Limit}$	$U_{a\text{-}Calc}$	$U_{i\text{-}Calc}$	Surface where the maximum value occurs*
Wall**	0.35	0.21	0.48	Z0/03/sei.1
Floor	0.25	0.09	0.09	Z0/03/f
Roof	0.25	0.13	0.13	Z2/02/ci
Windows***, roof windows, and rooflights	2.2	1.4	1.4	Z2/04/ne/g
Personnel doors	2.2	0.81	0.81	fe
Vehicle access & similar large doors	1.5	-	-	"No external vehicle access doors"
High usage entrance doors	3.5	-	-	"No external high usage entrance doors"

$U_{a\text{-}Limit}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-}Calc}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-}Calc}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

Air Permeability	Worst acceptable standard	This building
$m^3/(h.m^2)$ at 50 Pa	10	3

Building services

The standard values listed below are minimum values for efficiencies and maximum values for SFPs.
Refer to the Non-Domestic Building Services Compliance Guide for details.

Whole building lighting automatic monitoring & targeting with alarms for out-of-range values	YES
Whole building electric power factor achieved by power factor correction	>0.95

1- gas boiler

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.92	-	-	-	-
Standard value	0.91*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

2- a c

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	5	7	-	-	-
Standard value	2.5*	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

3- community heating

	Heating efficiency	Cooling efficiency	Radiant efficiency	SFP [W/(l/s)]	HR efficiency
This system	0.85	-	-	-	-
Standard value	0.75	N/A	N/A	N/A	N/A
Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system					YES

1- Default HWS

	Water heating efficiency	Storage loss factor [kWh/litre per day]
This building	Hot water provided by HVAC system	0.012
Standard value	N/A	N/A

1- CHP Generator

	CHPQA quality index	CHP electrical efficiency
This building	-	0.25
Standard value	Not provided	N/A

Local mechanical ventilation, exhaust, and terminal units

ID	System type in Non-domestic Building Services Compliance Guide
A	Local supply or extract ventilation units serving a single area
B	Zonal supply system where the fan is remote from the zone
C	Zonal extract system where the fan is remote from the zone
D	Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery
E	Local supply and extract ventilation system serving a single area with heating and heat recovery
F	Other local ventilation units
G	Fan-assisted terminal VAV unit
H	Fan coil units
I	Zonal extract system where the fan is remote from the zone with grease filter

Zone name	SFP [W/(l/s)]									HR efficiency	
ID of system type	A	B	C	D	E	F	G	H	I		
Standard value	0.3	1.1	0.5	1.9	1.6	0.5	1.1	0.5	1	Zone	Standard
Z0/01	-	-	-	0.4	-	-	-	-	-	0.66	0.5
Z0/02	-	-	-	-	-	-	-	-	-	-	N/A
Z0/04	-	-	-	0.4	-	-	-	-	-	0.66	0.5
Z0/05	-	-	-	-	-	-	-	-	-	-	N/A
Z0/03	0.4	-	-	0.4	-	-	-	-	-	0.66	0.5
Z1/02	0.4	-	-	0.4	-	-	-	-	-	0.66	0.5
Z1/03	0.4	-	-	0.4	-	-	-	-	-	0.66	0.5
Z2/01	-	-	-	-	-	-	-	-	-	-	N/A
Z2/02	-	-	-	-	-	-	-	-	-	-	N/A
Z2/04	0.4	-	-	-	-	-	-	-	-	-	N/A
Z3/02	-	-	-	-	-	-	-	-	-	-	N/A
Z4/02	-	-	-	-	-	-	-	-	-	-	N/A
Z5/02	-	-	-	-	-	-	-	-	-	-	N/A
Z6/02	-	-	-	-	-	-	-	-	-	-	N/A
Z3/01	-	-	-	-	-	-	-	-	-	-	N/A
Z4/01	-	-	-	-	-	-	-	-	-	-	N/A
Z5/01	-	-	-	-	-	-	-	-	-	-	N/A
Z3/03	0.4	-	-	-	-	-	-	-	-	-	N/A
Z4/03	0.4	-	-	-	-	-	-	-	-	-	N/A
Z5/03	0.4	-	-	-	-	-	-	-	-	-	N/A
Z0/06	0.4	-	-	0.4	-	-	-	-	-	0.66	0.5
Z1/01	0.4	-	-	0.4	-	-	-	-	-	0.66	0.5
Z2/03	0.4	-	-	-	-	-	-	-	-	-	N/A

General lighting and display lighting	Luminous efficacy [lm/W]			
Zone name	Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Z0/01	67	-	-	82
Z0/02	-	132	-	90
Z0/04	66	-	-	74
Z0/05	-	133	-	60
Z0/03	-	133	-	90
Z1/02	-	132	-	53
Z1/03	-	133	-	63
Z2/01	-	128	-	45
Z2/02	-	135	-	80
Z2/04	-	134	-	420
Z3/02	-	135	-	80
Z4/02	-	135	-	80
Z5/02	-	135	-	80
Z6/02	-	135	-	80
Z3/01	-	128	-	45
Z4/01	-	128	-	45

General lighting and display lighting

Zone name	Luminous efficacy [lm/W] Luminaire	Lamp	Display lamp	General lighting [W]
Standard value	60	60	22	
Z5/01	-	128	-	45
Z3/03	-	133	-	615
Z4/03	-	133	-	570
Z5/03	-	133	-	570
Z0/06	67	-	-	3840
Z1/01	-	134	-	2903
Z2/03	72	-	-	360

Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

Zone	Solar gain limit exceeded? (%)	Internal blinds used?
Z2/04	NO (-33.9%)	YES
Z3/03	NO (-16.1%)	YES
Z4/03	NO (-27.4%)	YES
Z5/03	NO (-27.4%)	YES
Z0/06	N/A	N/A
Z1/01	YES (+53.2%)	YES
Z2/03	YES (+232.6%)	YES

Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

EPBD (Recast): Consideration of alternative energy systems

Were alternative energy systems considered and analysed as part of the design process?	NO
Is evidence of such assessment available as a separate submission?	NO
Are any such measures included in the proposed design?	NO

Technical Data Sheet (Actual vs. Notional Building)

Building Global Parameters

	Actual	Notional
Area [m²]	2437.1	2437.1
External area [m²]	1642.7	1642.7
Weather	LON	LON
Infiltration [m³/hm²@ 50Pa]	3	3
Average conductance [W/K]	529.05	823.27
Average U-value [W/m²K]	0.32	0.5
Alpha value* [%]	16.23	15.81

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

Building Use

% Area	Building Type
	A1/A2 Retail/Financial and Professional services
	A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways
	B1 Offices and Workshop businesses
	B2 to B7 General Industrial and Special Industrial Groups
	B8 Storage or Distribution
	C1 Hotels
	C2 Residential Inst.: Hospitals and Care Homes
	C2 Residential Inst.: Residential schools
30	**C2 Residential Inst.: Universities and colleges**
	C2A Secure Residential Inst.
	Residential spaces
70	**D1 Non-residential Inst.: Community/Day Centre**
	D1 Non-residential Inst.: Libraries, Museums, and Galleries
	D1 Non-residential Inst.: Education
	D1 Non-residential Inst.: Primary Health Care Building
	D1 Non-residential Inst.: Crown and County Courts
	D2 General Assembly and Leisure, Night Clubs and Theatres
	Others: Passenger terminals
	Others: Emergency services
	Others: Miscellaneous 24hr activities
	Others: Car Parks 24 hrs
	Others - Stand alone utility block

Energy Consumption by End Use [kWh/m²]

	Actual	Notional
Heating	8.34	13.57
Cooling	3.43	3.93
Auxiliary	17.18	17.2
Lighting	14.22	16.09
Hot water	76.2	70.74
Equipment*	12.4	12.4
TOTAL**	**102.44**	**121.54**

* Energy used by equipment does not count towards the total for calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

Energy Production by Technology [kWh/m²]

	Actual	Notional
Photovoltaic systems	3	0
Wind turbines	0	0
CHP generators	16.95	0
Solar thermal systems	0	0

Energy & CO_2 Emissions Summary

	Actual	Notional
Heating + cooling demand [MJ/m²]	136.4	126.52
Primary energy* [kWh/m²]	155.7	214.57
Total emissions [kg/m²]	25.6	37.1

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

HVAC Systems Performance

System Type		Heat dem MJ/m2	Cool dem MJ/m2	Heat con kWh/m2	Cool con kWh/m2	Aux con kWh/m2	Heat SSEEF	Cool SSEER	Heat gen SEFF	Cool gen SEER
[ST] No Heating or Cooling										
	Actual	177	1.9	0	0	0.7	0	0	0	0
	Notional	188.5	1.2	0	0	1	0	0	----	----
[ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity										
	Actual	11.8	92.4	3.8	0	25.1	0.86	0	0.92	0
	Notional	97.9	66	33.2	0	23.9	0.82	0	----	----
[ST] Split or multi-split system, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity										
	Actual	5.6	116.6	0.3	6.2	12.7	4.9	5.23	5	7
	Notional	2.6	92	0.3	7.1	13.5	2.43	3.6	----	----

Key to terms

Heat dem [MJ/m2]	= Heating energy demand
Cool dem [MJ/m2]	= Cooling energy demand
Heat con [kWh/m2]	= Heating energy consumption
Cool con [kWh/m2]	= Cooling energy consumption
Aux con [kWh/m2]	= Auxiliary energy consumption
Heat SSEFF	= Heating system seasonal efficiency (for notional building, value depends on activity glazing class)
Cool SSEER	= Cooling system seasonal energy efficiency ratio
Heat gen SSEFF	= Heating generator seasonal efficiency
Cool gen SSEER	= Cooling generator seasonal energy efficiency ratio
ST	= System type
HS	= Heat source
HFT	= Heating fuel type
CFT	= Cooling fuel type

Key Features

The BCO can give particular attention to items with specifications that are better than typically expected.

Building fabric

Element	$U_{i\text{-}Typ}$	$U_{i\text{-}Min}$	Surface where the minimum value occurs*
Wall	0.23	0.18	Z0/03/nwu
Floor	0.2	0.09	Z0/03/f
Roof	0.15	0.13	Z2/02/ci
Windows, roof windows, and rooflights	1.5	1.4	Z2/04/ne/g
Personnel doors	1.5	0.81	fe
Vehicle access & similar large doors	1.5	-	"No external vehicle access doors"
High usage entrance doors	1.5	-	"No external high usage entrance doors"

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)] $U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

Air Permeability	Typical value	This building
$m^3/(h.m^2)$ at 50 Pa	5	3

SBEM Main Calculation Output Document

Sat Sep 12 11:07:28 2015 v5.2.d.2

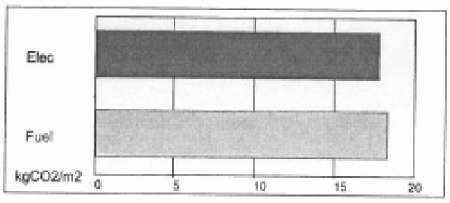
Building name

50 Birkenhead Street, London

Building type: D1 Non-residential Institutions - Community/Day Centre

SBEM is an energy calculation tool for the purpose of assessing and demonstrating compliance with Building Regulations (Part L for England and Wales, Section 6 for Scotland, Part F for Northern Ireland, Part L for Republic of Ireland and Building Bye-laws Jersey Part 11) and to produce Energy Performance Certificates and Building Energy Ratings. Although the data produced by the tool may be of use in the design process, SBEM is not intended as a building design tool.

Building Energy Performance and CO2 emissions

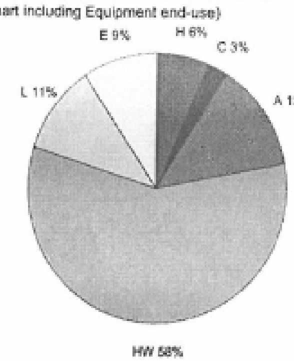


10 kgCO2/m2 displaced by the use of renewable sources.

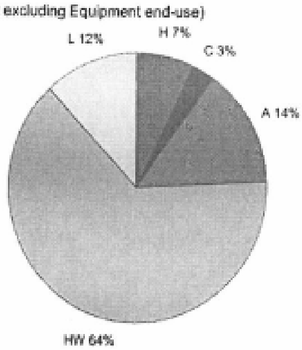
Building area is 2437.1 m2

Annual Energy Consumption

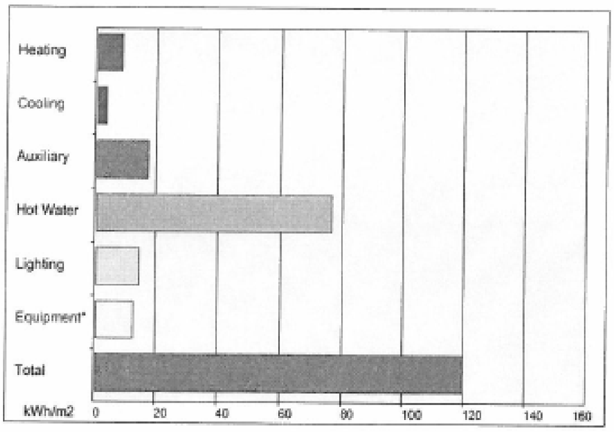
(Pie chart including Equipment end-use)

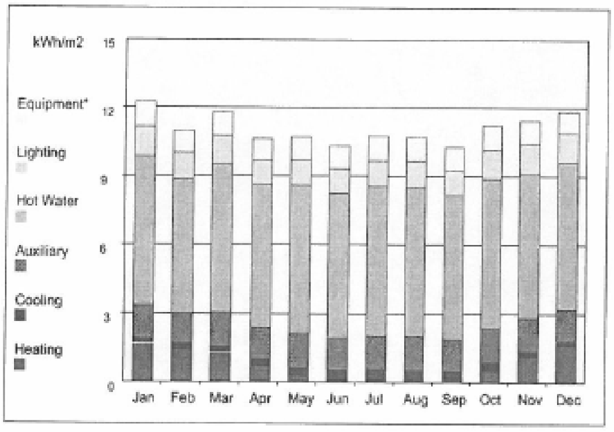


(Pie chart excluding Equipment end-use)

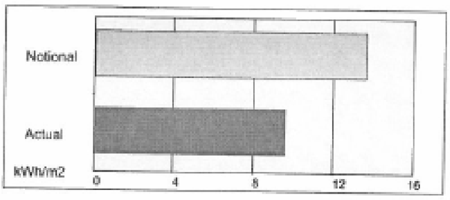


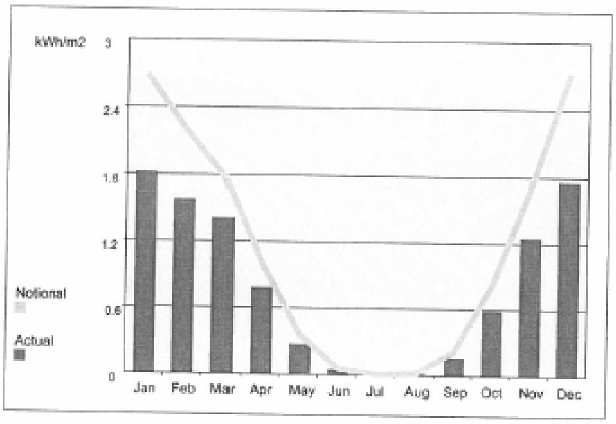
(*) Although energy consumption by equipment is shown in the graphs, the CO2 emissions associated with this end-use have not been taken into account when producing the rating.



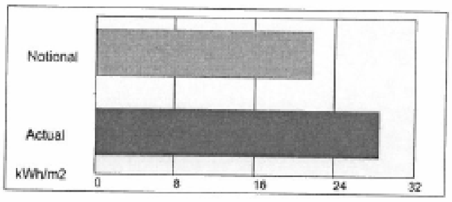


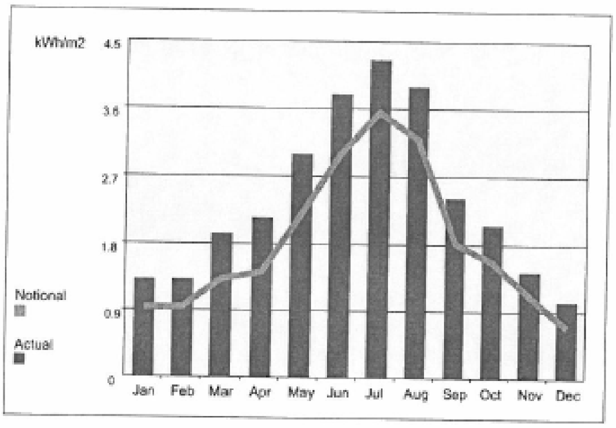
Annual Heating Demand





Annual Cooling Demand





APPENDIX 2: RESULTS OF THE SAP ASSESSMENT FOR THE LEASEHOLD AND WARDENS FLATS

		Lean				Clean (Lean + Community heating and				Green (Lean + ASHP)			
	Area	TER	BER	TER	BER	TER	BER	TER	BER	TER	BER	TER	BER
	m2	kgCO2/m2/annum		Tonnes		kgCO2/m2/annum		Tonnes		kgCO2/m2/annum		Tonnes	
Wardens Flat	87.5	14.4	13.52	1.26	1.18	14.18	9.5	1.24	0.83	20.15	12.04	1.76	1.05
R1.1	77	14.4	13.52	1.11	1.04	14.18	9.5	1.09	0.73	20.15	12.04	1.55	0.93
R1.2	74	14.4	13.52	1.07	1.00	14.18	9.5	1.05	0.70	20.15	12.04	1.49	0.89
R1.3	73	14.4	13.52	1.05	0.99	14.18	9.5	1.04	0.69	20.15	12.04	1.47	0.88
R2.1	77	14.4	13.52	1.11	1.04	14.18	9.5	1.09	0.73	20.15	12.04	1.55	0.93
R2.2	51	14.4	13.52	0.73	0.69	14.18	9.5	0.72	0.48	20.15	12.04	1.03	0.61
R2.3	50	14.4	13.52	0.72	0.68	14.18	9.5	0.71	0.48	20.15	12.04	1.01	0.60
R2.4	57	14.4	13.52	0.82	0.77	14.18	9.5	0.81	0.54	20.15	12.04	1.15	0.69
R3.1	72	14.4	13.52	1.04	0.97	14.18	9.5	1.02	0.68	20.15	12.04	1.45	0.87
R3.2	51	20.59	20.11	1.05	1.03	20.43	13.37	1.04	0.68	29.88	19.32	1.52	0.99
R3.3	50	20.59	20.11	1.03	1.01	20.43	13.37	1.02	0.67	29.88	19.32	1.49	0.97
R3.4	53	20.59	20.11	1.09	1.07	20.43	13.37	1.08	0.71	29.88	19.32	1.58	1.02
Residential	772.5			12.08	11.46			11.92	7.93			17.06	10.42
% Improvement BER/TER					5.1%				33.4%				38.9%

Table 8 – Summary of the results of the SAP analysis for the leasehold and Wardens flats

L1A 2013 - Regulations Compliance Report
Design - Draft

info@buildenergy.co.uk
01202 280062

This design draft submission provides evidence towards compliance with Part L of the Building Regulations, in accordance with Appendix C 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 Peter Mitchell	Assessor number	3635
Client		Last modified	20/08/2015
Address	Wardens King's Cross Methodist Church, London		

Check	Evidence	Produced by	OK?
Criterion 1: predicted carbon dioxide emission from proposed dwelling does not exceed the target			
TER (kg CO_2/m².a)	Fuel = N/A Fuel factor = 1.55 TER = 20.15	Authorised SAP Assessor	
DER for dwelling as designed (kg CO_2/m².a)	DER = 12.04	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 12.04 < TER 20.15	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 26.63 < TFEE 32.05	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 (no floor) Roof (no roof) Openings 1.20 (max 2.00) 1.40 (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 NIBE F370 Secondary heating system: None	Authorised SAP Assessor	
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: No hot water cylinder Boiler interlock (main system 1)	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 = 1 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 = 3.00 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 = 4.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Mechanical extract ventilation: SFP = 0.62 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 party walls have a U-value less than $0.2W/m^2K$: • Wall access (0.00) • Wall party (0.00) The following openings have a U-value less than $1.2W/m^2K$: • Solid door reference 7 (0.00)	Authorised SAP Assessor	

SAP Worksheet
Design - Draft

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Peter Mitchell	Assessor number	3635
Client		Last modified	20/08/2015
Address	Wardens King's Cross Methodist Church, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		89.10	(1a)	x	2.50	(2a)	=	222.75	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	89.10	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			222.75	(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		4.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.20	(18)
Number of sides on which the dwelling is sheltered		3	(19)
Shelter factor	1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.16	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.20	0.19	0.19	0.17	0.17	0.15	0.15	0.14	0.16	0.17	0.17	0.18	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
c) whole house extract ventilation or positive input ventilation from outside	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 (25)	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

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			11.05	x	1.33	=	14.65			(27)
Door			1.89	x	0.00	=	0.00			(26)
Party wall			106.91	x	0.00	=	0.00			(32)
External wall			28.25	x	0.18	=	5.09			(29a)
Total area of external elements ∑A, m²			41.19							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	19.73	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		6.93	(36)
Total fabric heat loss	(33) + (36) =	26.67	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	36.75	36.75	36.75	36.75	36.75	36.75	36.75	36.75	36.75	36.75	36.75	36.75	(38)
Heat transfer coefficient, W/K (37)m + (38)m	63.42	63.42	63.42	63.42	63.42	63.42	63.42	63.42	63.42	63.42	63.42	63.42	
Average = ∑(39)1...12/12 =												63.42	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	0.71	
Average = ∑(40)1...12/12 =												0.71	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	2.61	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	96.26	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	105.89	102.04	98.19	94.34	90.49	86.64	86.64	90.49	94.34	98.19	102.04	105.89	
∑(44)1...12 =												1155.16	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	157.03	137.34	141.72	123.56	118.56	102.31	94.80	108.79	110.08	128.29	140.04	152.08	
∑(45)1...12 =												1514.60	(45)
Distribution loss 0.15 x (45)m	23.55	20.60	21.26	18.53	17.78	15.35	14.22	16.32	16.51	19.24	21.01	22.81	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	170.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.84	(50)
Enter (50) or (54) in (55)	0.84	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	26.11	23.59	26.11	25.27	26.11	25.27	26.11	26.11	25.27	26.11	25.27	26.11	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	26.11	23.59	26.11	25.27	26.11	25.27	26.11	26.11	25.27	26.11	25.27	26.11	(57)

Primary circuit loss for each month from Table 3

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)

Combi loss for each month from Table 3a, 3b or 3c

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 x (45)m + (46)m + (57)m + (59)m + (61)m

183.15	160.93	167.84	148.83	144.67	127.58	120.92	134.90	135.36	154.41	165.31	178.19	(62)

Solar DHW input calculated using Appendix G or Appendix H

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)

Output from water heater for each month (kWh/month) (62)m + (63)m

183.15	160.93	167.84	148.83	144.67	127.58	120.92	134.90	135.36	154.41	165.31	178.19

∑(64)1...12 = 1822.08 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

52.21	45.67	47.12	41.08	39.42	34.02	31.52	36.17	36.60	42.66	46.56	50.57	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	156.79	156.79	156.79	156.79	156.79	156.79	156.79	156.79	156.79	156.79	156.79	156.79	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	58.43	51.90	42.21	31.95	23.89	20.16	21.79	28.32	38.01	48.27	56.33	60.05	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	354.35	358.02	348.76	329.03	304.13	280.73	265.09	261.42	270.68	290.41	315.31	338.71	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	53.29	53.29	53.29	53.29	53.29	53.29	53.29	53.29	53.29	53.29	53.29	53.29	(69)
Pump and fan gains (Table 5a)	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)
Losses e.g. evaporation (Table 5)	-104.53	-104.53	-104.53	-104.53	-104.53	-104.53	-104.53	-104.53	-104.53	-104.53	-104.53	-104.53	(71)
Water heating gains (Table 5)	70.18	67.96	63.34	57.06	52.98	47.25	42.37	48.62	50.84	57.34	64.67	67.96	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	588.51	583.43	559.86	523.60	486.56	453.69	434.81	443.91	465.09	501.57	541.87	572.29	(73)

6. Solar gains

	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	3.40	x	36.79	x 0.9 x	0.63	x	0.80	=	43.69	(79)
NorthEast	0.54	x	7.65	x	11.28	x 0.9 x	0.63	x	0.80	=	21.14	(75)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains in watts ∑(74)m...(82)m	64.84	117.46	179.37	253.51	312.49	322.79	305.98	260.06	204.74	134.85	78.94	54.66	(83)
Total gains - internal and solar (73)m + (83)m	653.35	700.89	739.23	777.11	799.05	776.48	740.78	703.97	669.83	636.42	620.81	626.95	(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 n1,m (see Table 9a)	0.99	0.98	0.95	0.88	0.72	0.52	0.38	0.41	0.64	0.90	0.98	0.99	(86)

Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

	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 rest of dwelling from Table 9, Th2(°C)

20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.98	0.94	0.85	0.67	0.47	0.32	0.35	0.59	0.87	0.97	0.99	(89)

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	20.33	(90)

Living area fraction — Living area ÷ (4) = 0.38 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2

20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	(92)

Apply adjustment to the mean internal temperature from Table 4e where appropriate

20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	20.58	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.98	0.95	0.86	0.69	0.49	0.34	0.38	0.61	0.88	0.97	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	645.45	685.11	700.69	668.55	550.60	378.49	252.50	265.13	406.96	560.09	604.33	621.25	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	1032.62	994.57	893.10	740.89	563.31	379.39	252.55	265.24	411.10	633.07	855.04	1038.96	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	288.05	207.95	143.15	52.09	9.45	0.00	0.00	0.00	0.00	54.30	180.51	310.78	

∑(98)1...5, 10...12 = 1246.28 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 13.99 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
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 system 1 (%)		298.74	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	96.42	69.61	47.92	17.44	3.16	0.00	0.00	0.00	0.00	18.18	60.43	104.03

∑(211)1...5, 10...12 = 417.19 (211)

Water heating

Efficiency of water heater

220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	(217)

Water heating fuel, kWh/month

82.99	72.92	76.05	67.44	65.56	57.81	54.79	61.13	61.33	69.97	74.91	80.74

∑(219a)1...12 = 825.65 (219)

Annual totals

Space heating fuel - main system 1 — 417.19

Water heating fuel					825.65	
Electricity for pumps, fans and electric keep-hot (Table 4f)						
mechanical ventilation fans - balanced, extract or positive input from outside			144.73			(230a)
Total electricity for the above, kWh/year					144.73	(231)
Electricity for lighting (Appendix L)					412.76	(232)
Total delivered energy for all uses				(211)...(221) + (231) + (232)...(237b) =	1800.32	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	417.19	x	13.19	x 0.01 =	55.03	(240)
Water heating	825.65	x	13.19	x 0.01 =	108.90	(247)
Pumps and fans	144.73	x	13.19	x 0.01 =	19.09	(249)
Electricity for lighting	412.76	x	13.19	x 0.01 =	54.44	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	237.46	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	0.74	(257)
SAP value	89.62	
SAP rating (section 13)	90	(258)
SAP band	B	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	417.19	x	0.52	=	216.52	(261)
Water heating	825.65	x	0.52	=	428.51	(264)
Space and water heating				(261) + (262) + (263) + (264) =	645.03	(265)
Pumps and fans	144.73	x	0.52	=	75.11	(267)
Electricity for lighting	412.76	x	0.52	=	214.22	(268)
Total CO_2, kg/year				(265)...(271) =	934.37	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	10.49	(273)
EI value					90.66	
EI rating (section 14)					91	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	417.19	x	3.07	=	1280.76	(261)
Water heating	825.65	x	3.07	=	2534.73	(264)
Space and water heating				(261) + (262) + (263) + (264) =	3815.49	(265)
Pumps and fans	144.73	x	3.07	=	444.31	(267)
Electricity for lighting	412.76	x	3.07	=	1267.18	(268)
Primary energy kWh/year					5526.98	(272)
Dwelling primary energy rate kWh/m2/year					62.03	(273)

L1A 2013 - Regulations Compliance Report
Design - Draft

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This design draft submission provides evidence towards compliance with Part L of the Building Regulations, in accordance with Appendix C 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 Peter Mitchell	Assessor number	3635
Client		Last modified	20/08/2015
Address	R3.2 King's Cross Methodist Church, 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 = N/A Fuel factor = 1.55 TER = 29.88	Authorised SAP Assessor	
DER for dwelling as designed (kg CO_2/m^2.a)	DER = 19.32	Authorised SAP Assessor	
Are emissions from dwelling as designed less than or equal to the target?	DER 19.32 < TER 29.88	Authorised SAP Assessor	Passed
Is the fabric energy efficiency of the dwellling as designed less than or equal to the target?	DFEE 43.85 < TFEE 50.54	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: (no floor) Roof: 0.13 (max 0.20) / 0.13 (max 0.35) Openings: 1.31 (max 2.00) / 1.40 (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 NIBE F370 Secondary heating system: None	Authorised SAP Assessor	
Does the insulation of the hot water cylinder meet the standards set out in the Domestic Heating Compliance Guide?	No hot water cylinder	Authorised SAP Assessor	
Do controls meet the minimum controls provision set out in the Domestic Heating Compliance Guide?	Space heating control: Time and temperature zone control - plumbing circuit Hot water control: No hot water cylinder Boiler interlock (main system 1)	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 = 1 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 = 3.00 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 = 4.00 Max air permeability = 10.00	Authorised SAP Assessor	Passed
Mechanical ventilation system Specific fan power (SFP)	Mechanical extract ventilation: SFP = 0.66 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 party walls have a U-value less than $0.2W/m^2K$: • Wall party (0.00) The following openings have a U-value less than $1.2W/m^2K$: • Solid door reference 6 (1.00)	Authorised SAP Assessor	

SAP Worksheet
Design - Draft

info@buildenergy.co.uk
01202 280062

This design submission has been carried out using Approved SAP software. It has been prepared from plans and specifications and may not reflect the property as constructed.

Assessor name	Mr Peter Mitchell	Assessor number	3635
Client		Last modified	20/08/2015
Address	R3.2 King's Cross Methodist Church, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		50.40	(1a)	x	2.90	(2a)	=	146.16	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	50.40	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	146.16	(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		4.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.20	(18)
Number of sides on which the dwelling is sheltered		3	(19)
Shelter factor	1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.16	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.20	0.19	0.19	0.17	0.17	0.15	0.15	0.14	0.16	0.17	0.17	0.18	(22b)

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	N/A	(23c)

c) whole house extract ventilation or positive input ventilation from outside

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
(24c)	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	(24c)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	0.57	(25)

3. Heat losses and heat loss parameter

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			6.74	x	1.33	=	8.94			(27)
Door			1.89	x	1.00	=	1.89			(26)
External wall			21.17	x	0.18	=	3.81			(29a)
Party wall			51.40	x	0.00	=	0.00			(32)
Roof			52.40	x	0.13	=	6.81			(30)
Total area of external elements ∑A, m²			82.20							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	21.45	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		6.63	(36)
Total fabric heat loss	(33) + (36) =	28.08	(37)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	27.59	27.59	27.59	27.59	27.59	27.59	27.59	27.59	27.59	27.59	27.59	27.59	(38)
Heat transfer coefficient, W/K (37)m + (38)m	55.67	55.67	55.67	55.67	55.67	55.67	55.67	55.67	55.67	55.67	55.67	55.67	
Average = ∑(39)1...12/12 =												55.67	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	
Average = ∑(40)1...12/12 =												1.10	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.70	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	74.62	(43)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	82.08	79.10	76.11	73.13	70.14	67.16	67.16	70.14	73.13	76.11	79.10	82.08	
∑(44)1...12 =												895.44	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	121.72	106.46	109.86	95.78	91.90	79.30	73.49	84.33	85.33	99.45	108.56	117.88	
∑(45)1...12 =												1174.06	(45)
Distribution loss 0.15 x (45)m	18.26	15.97	16.48	14.37	13.79	11.90	11.02	12.65	12.80	14.92	16.28	17.68	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	170.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.56	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.84	(50)
Enter (50) or (54) in (55)	0.84	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	26.11	23.59	26.11	25.27	26.11	25.27	26.11	26.11	25.27	26.11	25.27	26.11	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	26.11	23.59	26.11	25.27	26.11	25.27	26.11	26.11	25.27	26.11	25.27	26.11	(57)

Primary circuit loss for each month from Table 3

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)

Combi loss for each month from Table 3a, 3b or 3c

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 x (45)m + (46)m + (57)m + (59)m + (61)m

147.84	130.05	135.97	121.05	118.01	104.58	99.60	110.44	110.61	125.56	133.83	144.00	(62)

Solar DHW input calculated using Appendix G or Appendix H

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)

Output from water heater for each month (kWh/month) (62)m + (63)m

147.84	130.05	135.97	121.05	118.01	104.58	99.60	110.44	110.61	125.56	133.83	144.00	

∑(64)1...12 = 1481.53 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]

40.47	35.40	36.53	31.85	30.56	26.37	24.43	28.04	28.37	33.07	36.09	39.20	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	102.11	102.11	102.11	102.11	102.11	102.11	102.11	102.11	102.11	102.11	102.11	102.11	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	35.52	31.55	25.66	19.43	14.52	12.26	13.25	17.22	23.11	29.34	34.25	36.51	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	221.30	223.60	217.81	205.49	189.94	175.32	165.56	163.26	169.05	181.37	196.92	211.54	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	46.91	46.91	46.91	46.91	46.91	46.91	46.91	46.91	46.91	46.91	46.91	46.91	(69)
Pump and fan gains (Table 5a)	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)
Losses e.g. evaporation (Table 5)	-68.08	-68.08	-68.08	-68.08	-68.08	-68.08	-68.08	-68.08	-68.08	-68.08	-68.08	-68.08	(71)
Water heating gains (Table 5)	54.40	52.68	49.10	44.23	41.07	36.62	32.84	37.69	39.41	44.44	50.13	52.68	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	392.18	388.78	373.52	350.10	326.48	305.16	292.60	299.12	312.52	336.11	362.25	381.68	(73)

6. Solar gains

	Access factor Table 6d		Area m²		Solar flux W/m²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
NorthEast	0.77	x	3.51	x	11.28	x 0.9 x	0.63	x	0.80	=	13.83	(75)
NorthEast	0.54	x	1.43	x	11.28	x 0.9 x	0.63	x	0.80	=	3.95	(75)
SouthWest	0.54	x	1.80	x	36.79	x 0.9 x	0.63	x	0.80	=	16.22	(79)

Solar gains in watts ∑(74)m...(82)m	34.01	63.83	103.03	153.96	196.45	205.59	193.82	160.50	120.41	74.78	41.81	28.41	(83)
Total gains - internal and solar (73)m + (83)m	426.18	452.61	476.55	504.06	522.94	510.75	486.42	459.62	432.93	410.89	404.06	410.09	(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 n1,m (see Table 9a)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	0.99	0.99	0.97	0.93	0.83	0.66	0.50	0.54	0.78	0.94	0.98	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	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 rest of dwelling from Table 9, Th2(°C)	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	(88)
Utilisation factor for gains for rest of dwelling η2,m	0.99	0.98	0.96	0.91	0.78	0.57	0.39	0.43	0.71	0.92	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	20.00	(90)

Living area fraction — Living area ÷ (4) = 0.45 (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	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	20.44	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.98	0.97	0.92	0.81	0.61	0.44	0.48	0.74	0.93	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	421.48	445.01	461.19	464.46	422.03	313.26	212.33	222.30	321.64	383.18	396.07	406.37	(95)
Monthly average external temperature from Table U1	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]	898.74	865.34	776.27	642.67	486.80	325.37	214.03	225.17	353.20	548.04	742.87	904.31	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	355.08	282.46	234.42	128.31	48.19	0.00	0.00	0.00	0.00	122.65	249.70	370.47	

∑(98)1...5, 10...12 = 1791.29 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 35.54 (99)

9a. Energy requirements - individual heating systems including micro-CHP

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =	1.00	(202)
Fraction of space heat from main system 2		0.00	(202)
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 system 1 (%)		287.12	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	123.67	98.38	81.64	44.69	16.78	0.00	0.00	0.00	0.00	42.72	86.97	129.03

∑(211)1...5, 10...12 = 623.87 (211)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Efficiency of water heater	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	220.69	(217)
Water heating fuel, kWh/month	66.99	58.93	61.61	54.85	53.48	47.39	45.13	50.04	50.12	56.90	60.64	65.25	

∑(219a)1...12 = 671.33 (219)

Annual totals

Space heating fuel - main system 1			623.87	
Water heating fuel			671.33	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	127.18			(230a)
Total electricity for the above, kWh/year			127.18	(231)
Electricity for lighting (Appendix L)			250.95	(232)
Total delivered energy for all uses		(211)...(221) + (231) + (232)...(237b) =	1673.33	(238)

10a. Fuel costs - individual heating systems including micro-CHP

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	623.87	x	13.19	x 0.01 =	82.29	(240)
Water heating	671.33	x	13.19	x 0.01 =	88.55	(247)
Pumps and fans	127.18	x	13.19	x 0.01 =	16.77	(249)
Electricity for lighting	250.95	x	13.19	x 0.01 =	33.10	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	220.71	(255)

11a. SAP rating - individual heating systems including micro-CHP

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	0.97	(257)
SAP value	86.44	
SAP rating (section 13)	86	(258)
SAP band	B	

12a. CO_2 emissions - individual heating systems including micro-CHP

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	623.87	x	0.52	=	323.79	(261)
Water heating	671.33	x	0.52	=	348.42	(264)
Space and water heating				(261) + (262) + (263) + (264) =	672.21	(265)
Pumps and fans	127.18	x	0.52	=	66.00	(267)
Electricity for lighting	250.95	x	0.52	=	130.24	(268)
Total CO_2, kg/year				(265)...(271) =	868.46	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	17.23	(273)
EI value					87.80	
EI rating (section 14)					88	(274)
EI band					B	

13a. Primary energy - individual heating systems including micro-CHP

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	623.87	x	3.07	=	1915.29	(261)
Water heating	671.33	x	3.07	=	2061.00	(264)
Space and water heating				(261) + (262) + (263) + (264) =	3976.28	(265)
Pumps and fans	127.18	x	3.07	=	390.43	(267)
Electricity for lighting	250.95	x	3.07	=	770.41	(268)
Primary energy kWh/year					5137.12	(272)
Dwelling primary energy rate kWh/m2/year					101.93	(273)