Energy Statement

Warmhaze Ltd.

17-27 & 25 Ferdinand Street

Final

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Executive Summary

The Energy Strategy for the proposed development at 17-27 and 25 Ferdinand Street by Warmhaze Ltd in the London Borough of Camden has been formulated following the London Plan Energy Hierarchy**: Be Lean**, **Be Clean** and **Be Green**. The overriding objective in the formulation of the strategy is to maximise the reductions in CO_2 emissions through the application of this Hierarchy with a cost-effective, viable and technically appropriate approach and to minimise the emission of other pollutants.

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The Site will be built under Part L 2013 of the Building Regulations; therefore, in line with the London Plan, will target a 35% CO_2 reduction over the Part L 2013 baseline.

A range of advanced ***Be Lean*** energy efficiency measures are proposed. They enable the proposed development to exceed Part L1A 2013 Target Emission Rate (TER) and Target Fabric Energy Efficiency (TFEE) minimum standards for the residential aspect of the development through energy efficiency measures alone. A site-wide **4%** and **2%** reduction in regulated and total CO_2 emissions respectively is predicted over the Part L 2013 baseline. This represents a high level of sustainable design and construction.

In line with the London Plan, the feasibility of decentralised energy production as a **Be Clean** measure has been assessed. There are currently no existing or proposed district heat networks in the area. It has been concluded that a communal heating strategy is inappropriate for a development of this size as it would substantially increase capital costs and operational costs (and resident energy bills).

The full spectrum of **Be Green** renewable energy generating technologies has been considered. PV panels are considered the most appropriate but conflicts with the proposed green roofs on the development which are a Camden council preference. The applicant has therefore explored two scenarios:

> **Scenario 1: Green Roofs and Carbon Offsetting Payment (no solar PV)** - The overall energy strategy measures employed (*Be* Lean only) will result in a **4%** reduction in regulated CO_2 emissions and **2%** reduction in total (including unregulated) CO_2 emissions over the Part L 2013 baseline. A carbon offsetting cost of **£13,853** will therefore be paid to Camden Borough Council. This strategy complies with the London Plan, Code for Sustainable Homes Level 3 mandatory energy credits and Camden Borough Council policies.

> **Scenario 2: Solar PV but No Green Roofs** – 16.5kWp solar PV will be installed instead of green roofs to achieve an estimated further regulated and total CO_2 emission reduction of **32%** and **16%** after **Be Lean** emissions. The combination of **Be Lean** and **Be Green** measures will result in a **35%** reduction in regulated CO_2 emissions and **18%** reduction in total (including unregulated) CO_2

emissions over the Part L 2013 baseline. This strategy complies with the London Plan, Code for Sustainable Homes Level 4 mandatory energy credits and Camden Borough Council policies.

The applicant seeks guidance from Camden Borough Council on which strategy they would favour taking forward.

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1. INTRODUCTION

1.1 This Energy Statement has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, appointed by Warmhaze Ltd (hereafter referred to as 'the Applicant'). This Statement sets out the energy strategy for the proposed development at 17-27 and 25 Ferdinand Street in the London Borough of Camden.

1.2 The formulation of the energy strategy for the Proposed Development takes into account several important concerns and priorities. These include:

> To achieve the maximum viable reduction in carbon dioxide (CO_2) emissions through the application of the London Plan Energy Hierarchy with an affordable, deliverable and technically appropriate strategy;

> Provision of high quality low energy homes that are adapted to future changes in climate.

1.3 This statement first establishes a baseline assessment of the energy demands and associated CO_2 emissions for the Proposed Development based on Building Regulations (2013). The report will then follow The London Plan Energy Hierarchy approach of **Be Lean**, **Be Clean** and **Be Green** to enable the maximum viable reductions in Regulated and Total CO_2 emissions over the baseline.

2. DEVELOPMENT PROPOSALS

2.1 The site is located in the London Borough of Camden on Ferdinand Street to the north of Chalk Farm Road as illustrated in Figure 1.

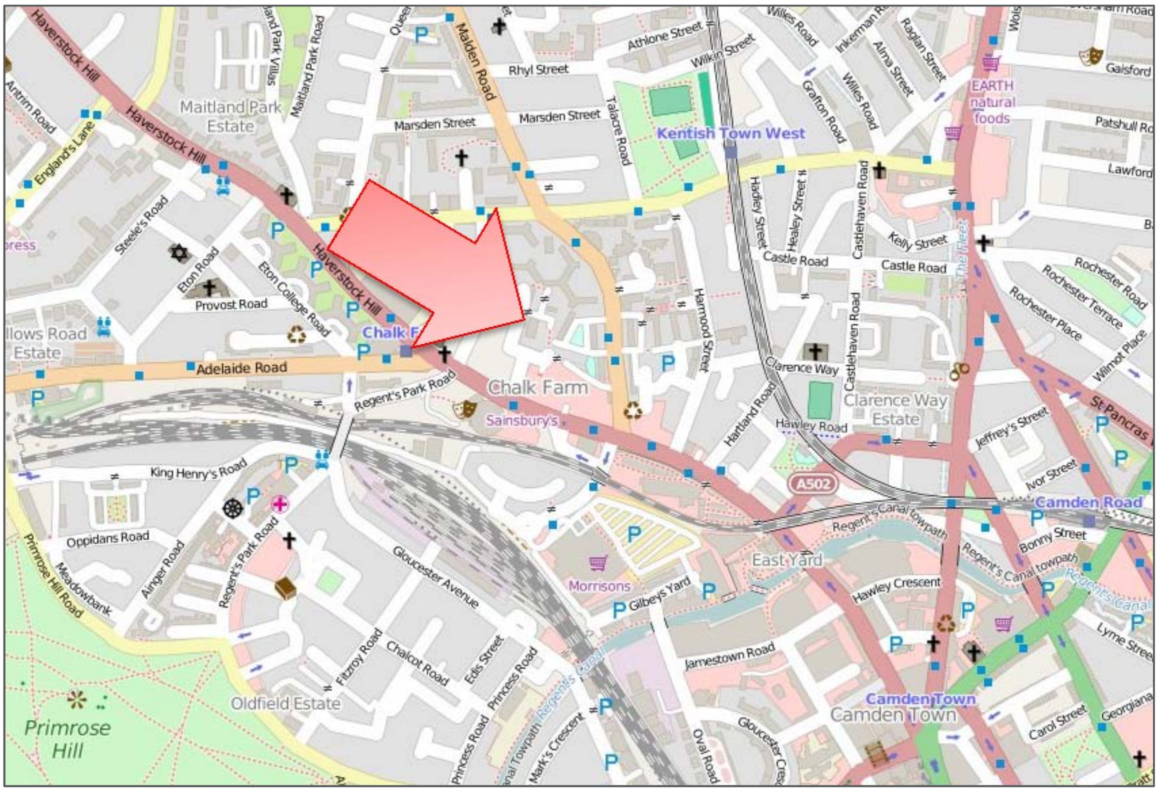

Figure 1: Site Location

Background Information

2.2 The application site was subject to a previous planning application, reference 2012/4782/P which proposed the following:

Erection of an additional 4th and 5th floor, erection of a 5 storey extension to courtyard (west) elevation and erection of a single storey extension to east elevation all at 17 and 27 Ferdinand Street, and redevelopment of 25 Ferdinand Street to create a 5 storey building, to provide 9 residential units (Class C3) (2 x 1-bed, 4 x 2-bed, 2 x 3-bed, 1 x 4-bed) and office space (Class B1), including an external terraced area at 5th floor level, creation of green roof, and associated alterations.

2.3 In terms of sustainability the application targeted Code for Sustainable Homes Level 3 for the residential units and BREEAM Very Good for the office space. The application was approved in December 2012.

Development Proposal

2.4 The proposal consists of the redevelopment of the existing site to provide 20 new residential apartments. It includes outdoor space, cycle parking provision, refuse and recycling storage areas and a green roof.

2.5 The built form of the proposed development matches that of the previous application for this site (application reference 2012/4782/P). The predominant change is the alteration to a completely residential use throughout the site to provide the 20 proposed apartments.

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3. PLANNING POLICIES & DEVELOPMENT REQUIREMENTS

3.1 The following planning policies and requirements will inform the Energy and Sustainability Strategy for the proposed development.

National Planning Policy

3.2 **The National Planning Policy Framework (NPPF)** was published on 27 March 2012. This document sets the overarching policies for development in England and states that:

"At the heart of the NPPF is a presumption in favour of sustainable development, which should be seen as a golden thread running through both plan-making and decision-taking.

For decision-taking this means:

> *Approving development proposals that accord with the development plan without delay; and*

> *Where the development plan is absent, silent or relevant policies are out-of-date, granting permission unless:*

> *Any adverse impacts of doing so would significantly and demonstrably outweigh the benefits, when assessed against the policies in this Framework taken as a whole; or*

> *Specific policies in this Framework indicate development should be restricted."*

3.3 Paragraph 95 of the NPPF states that:

“To support the move to a low carbon future, local planning authorities should:

> *Plan for new development in locations and ways which reduce greenhouse gas emissions;*

> *Actively support energy efficiency improvements to existing buildings; and*

> *When setting any local requirement for a building’s sustainability, do so in a way consistent with the Government’s zero carbon buildings policy and adopt nationally described standards*.”

3.4 The document also makes it clear that the delivery of a wide choice of well-designed high quality homes is central to delivering sustainable development.

Regional Policy

3.5 **The London Plan (July 2011)** sets out an integrated economic, environmental, transport and social framework for the development of London over the next 20 – 25 years. On 11 October 2013, the Mayor published Revised Early Minor Alterations to the London Plan (REMA). From this date, the REMA are operative as formal alterations to the London Plan (the Mayor’s spatial development strategy) and form part of the development plan for Greater London.

3.6 The following outlines key policies set out in the London Plan which must be addressed by new developments and which are relevant to the Proposed Development.

3.7 **Policy 5.2 – Minimising Carbon Dioxide Emissions** requires that all residential buildings between 2013 – 2016 achieve a 40% improvement on 2010 Building Regulations. The London Plan Sustainable Design and Construction SPG (2014) updates this target stating that the Mayor will adopt a carbon dioxide improvement target beyond Part L 2013 of 35%.

3.8 **Policy 5.3 – Sustainable Design and Construction** states that the highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments. Major development should meet the minimum standards outlined in the London Plan Supplementary Planning Guidance and this should be clearly demonstrated. The standards include the following sustainable design principles (summarised):

> Minimising CO_2 emissions;

> Avoiding internal overheating and contributing to the urban heat island effect;

> Efficient use of natural resources (including water);

> Minimising pollution (including noise, air and urban run-off);

> Minimising the generation of waste and maximising reuse and recycling;

> Avoiding impacts from natural hazards (including flooding);

> Ensuring developments are comfortable and secure for users;

> Securing sustainable procurement of materials, using local suppliers where feasible; and

> Promoting and protecting biodiversity and green infrastructure.

3.9 **Policy 5.5 – Decentralised Energy Networks** states that the Mayor expects 25 per cent of the heat and power used in London to be generated through the use of localised decentralised energy systems by 2025. The Mayor will prioritise the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.

3.10 **Policy 5.6 - Decentralised Energy** requires that all developments should evaluate the feasibility of Combined Heat and Power (CHP) systems, and examine the opportunities to extend the system beyond the site boundary to adjacent sites.

3.11 **Policy 5.7 – Renewable Energy** states that within the framework of the energy hierarchy, major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible.

3.12 **Policy 5.8 – Innovative Energy Technologies** encourages the more widespread use of innovative energy technologies to reduce use of fossil fuels and carbon dioxide emissions.

3.13 **Policy 5.9 – Overheating and Cooling** seeks to reduce the impact of the urban heat island effect, reduce potential overheating and reduce reliance on air conditioning systems.

3.14 **Policy 5.10 – Urban Greening** encourages new planting in the public realm (including streets, squares and plazas) and green infrastructure, to contribute to the adaptation to, and mitigation of, the effects of climate change.

3.15 **The London Plan Supplementary Planning Guidance – Sustainable Design and Construction (2014)** includes relevant energy guidance on:

> Energy efficient design;

> Meeting carbon dioxide reduction targets;

> Decentralised energy;

> How to off-set carbon dioxide where the targets set out in the London Plan are not met;

> Retro-fitting measures;

> Support for monitoring energy use during occupation.

3.16 Each section of the Supplementary Planning Guidance sets out the Mayor's priorities for the particular topic area, which the Mayor seeks developers to address in all development proposals. Some sections also contain best practice ambitions, which the Mayor strongly encourages be delivered in appropriate developments. To support these approaches, the Supplementary Planning Guidance includes detailed guidance for boroughs and developers, signposts to further information and best practice examples.

3.17 **The London Housing Supplementary Planning Guidance (2012)** states that designers should seek to achieve a minimum of Level 4 of the Code for Sustainable Homes in all new development.

Local Policy: The London Borough of Camden

Core Strategy

3.18 The Camden Core Strategy was adopted in November 2010. The following policies are considered to be pertinent to this Statement:

3.19 **Policy CS13 – Tackling climate change through promoting higher environmental standards**: The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by:

> Ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;

> Promoting the efficient use of land and buildings;

> Minimising carbon emissions from the redevelopment, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy: Ensuring developments use less energy; making use of energy from efficient sources; generating renewable energy on-site;

> Ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

3.20 The Council will promote local energy generation and networks by working with partners and developers to implement local energy networks and protecting existing local energy networks where possible.

Development Policies

3.21 Camden's Development Policies were adopted in November 2010. The following policies are considered to be pertinent to this Statement:

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

> Expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 **and Code Level 4 by 2013** and encouraging Code Level 6 (zero carbon) by 2016;

> Expecting developments (except new build) of 500sqm of residential floorspace or above or 5 or more dwellings to achieve 'Very Good' in EcoHomes assessments prior to 2013 and encouraging **'Excellent' from 2013**.

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

> Summer shading and planting;

> Limiting run-off;

> Reducing water consumption;

> Reducing air pollution; and

> Not locating vulnerable uses in basements in flood-prone areas.

Camden Policy Guidance - Sustainability

3.24 This Policy Guidance document has been prepared by Camden to support the adopted Core Strategy and Development Policies. This Policy Guidance was last updated in September 2013. Relevant guidance within this document considered pertinent to this Statement includes the following:

> All developments are expected to reduce their carbon dioxide emissions by following the steps in the energy hierarchy, Be Lean, Be Clean, Be Green, to reduce energy consumption;

- Developments are to target a 20% reduction in carbon dioxide emissions from on-site renewable energy technologies unless it can be demonstrated that such provision is not feasible;
- The performance of water minimisation measures will be assessed against the water category in the Code for Sustainable Homes assessment;
- Prioritise the reduction, re-use and recycling of materials and sourcing materials responsibly;
- Code for Sustainable Homes Level 4 should be achieved (2013-2015) achieving 50% of the credits available in the Energy, Water and Materials categories;
- EcoHomes ‘Excellent’ should be achieved (2013+) achieving 60% of the credits available in the Energy and Water categories and 40% of the available credits in the Materials category;
- Green and brown roofs should be incorporated;
- Drainage and surface water should be managed on-site using Sustainable Drainage Systems (SUDS);
- Biodiversity considerations should be incorporated into the development.

Summary of Targets

3.25 The following policies will be addressed in this Energy Statement:

- London Plan (2011), London Borough of Camden Policy CS13 (2010), and further Camden Sustainability Policy Guidance (2013): Application of the energy hierarchy;
- London Plan (2011) Policy 5.2: Reduce Regulated CO_2 emissions by 35% over 2013 Part L baseline;
- London Borough of Camden Development Policies (2010): Code for Sustainable Homes Level 4;
- London Borough of Camden Sustainability Policy Guidance (2013): 20% reduction in carbon dioxide emissions from on-site renewable energy technologies unless it can be demonstrated that such provision is not feasible.

4. BUILDING REGULATIONS PART L 2013 BASELINE

Methodology

4.1 In line with London Plan policy, this statement first establishes a baseline assessment of the energy demands and associated CO_2 emissions for the Proposed Development based on Building Regulations (2013). The report will then follow The London Plan Energy Hierarchy approach of **Be Lean**, **Be Clean** and **Be Green** to enable the maximum viable reductions in Regulated and Total CO_2 emissions over the baseline.

4.2 The estimated annual energy demand for the residential portion of the Proposed Development has been calculated using Standard Assessment Procedure (SAP 2012) methodology. SAP calculates the Regulated energy demands associated with hot water, space heating and fixed electrical items. The unregulated energy demands for appliances and cooking are taken from BRE occupancy based calculations.

Building Regulations Part L 2013 Baseline

4.3 The Building Regulations compliant baseline is calculated using the dwelling TER. Table 1 below shows the 2013 Building Regulations compliant Regulated & Total CO_2 emissions for whole site. These are shown in greater detail in Appendix B.

Table 1: Building Regulations Part L 2013 Baseline

	Regulated CO_2 (kg/yr)	Total CO_2 (kg/yr)
Building Regulations (2013) Baseline	**24,702**	**48,338**

5. BE LEAN: ENERGY EFFICIENCY MEASURES

5.1 In line with the London Plan Energy Hierarchy, the following energy efficient, **Be Lean** measures are proposed to be applied to the Proposed Development. These measures will ensure that the required reduction in CO_2 emissions is met partly through energy efficiency.

Insulation Standards

5.2 The new build elements will incorporate enhanced insulation in the building envelope (walls, roofs, floors and glazing) to achieve average U-values better than those required by Part L Building Regulations. These are likely to include:

Element	Value	Description
Wall U-Value	0.16 W/m²K	Approx. 400mm wall.
Curtain Wall Average U-Value (top floor only)	0.80 W/m²K	Includes glazing and opaque system.
Ground Floor U-Value	0.10 W/m²K	TBC
Roof U-Value	0.10 W/m²K	TBC
Glazing U-Value	0.90 W/m²K	Triple glazing (necessary for TFEE).
Glazing G-Value	General: 0.50 Penthouses: 0.30	For overheating mitigation.
Thermal Bridging	0.15 W/mK	Default value assumed.
Air Permeability	3.0 m³/hr/m²	Necessary for TFEE.

Air Tightness and Ventilation

5.3 In order to ensure sufficient fresh air is provided to all the homes, it is proposed to install a Parts L & F compliant (System 4) Mechanical Ventilation with Heat Recovery (MVHR). The system will draw in sufficient external fresh air in from a height considered acceptable.

5.4 The selected MVHR units will have a Specific Fan Power (SFP) lower than 0.5 W/l/s and heat recovery efficiencies in excess of 90% and will remove stale air and odours from kitchens and bathrooms, whilst retaining the heat within living spaces. In this way, substantial energy savings will be made. This system is illustrated in Figure 2.

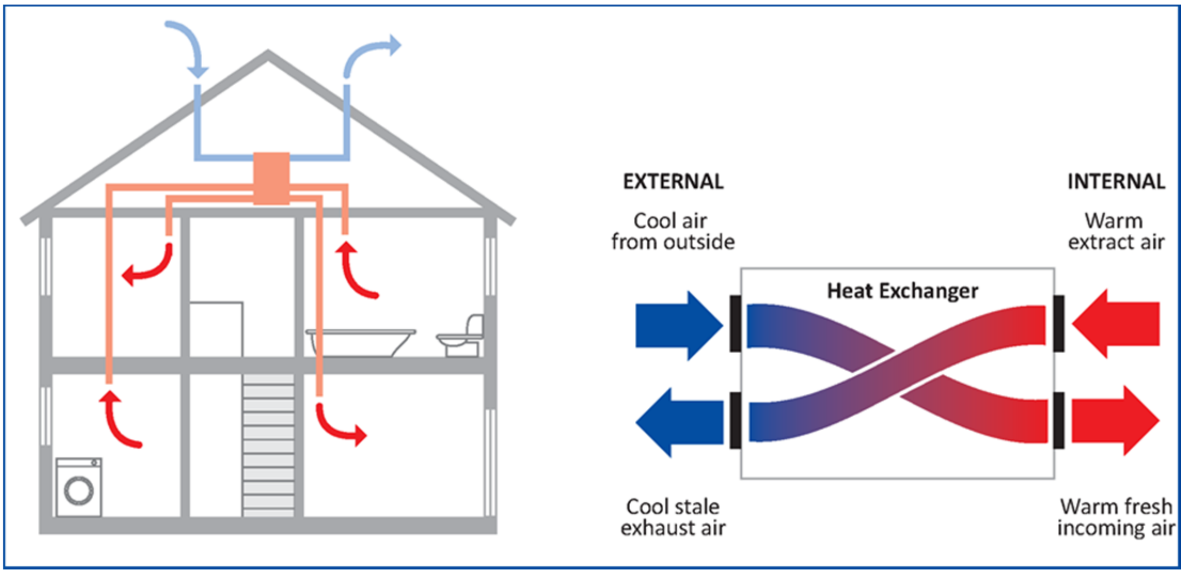

Figure 2: MVHR

5.5 Additionally, all dwellings will have openable windows and therefore the ability to naturally ventilate should the occupant desire. Convective ventilation, cross ventilation and night purging of heat will therefore be facilitated.

5.6 Air tightness standards will conform to, and exceed, Approved Document Part L requirements. By reducing air leakage loss and convective bypass of insulation, an improvement of design air permeability rate from $10m^3/hm^2$ to $3m^3/hm^2$ will further reduce space heating requirements.

Thermal Bridging

5.7 In well insulated buildings, as much as 30% of heat loss can occur through thermal bridges, which occur when highly conductive elements (e.g. metal studs) in the wall construction enable a low resistance escape route for heat. It is proposed that the development will aim to follow Accredited

Construction Details (ACD) for all possible thermal bridges. However, due to the construction of the building which includes retained elements and curtain walling, this will in many cases be unfeasible. Therefore, the default thermal bridging value of 0.15W/mK has been assumed within SAP calculations.

5.8 To significantly reduce heat loss through thermal bridging split independent lintels will be used over openings. These reduce the heat lost though this junction by 70% compared to a standard construction detail (default psi-value).

5.9 Figure 3 illustrates the benefits of reducing thermal bridges.

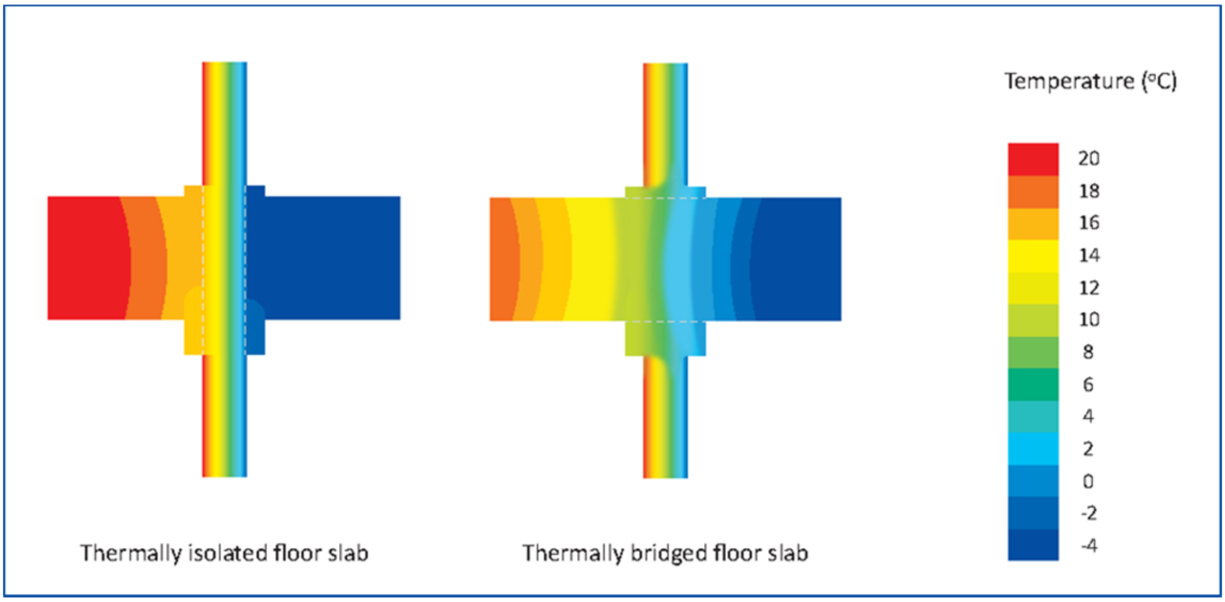

Figure 3: Thermal Bridging

Space Heating & Hot Water

5.10 The space heating requirement of the Proposed Development will be reduced by the fabric and air tightness measures detailed above. The combination of the above measures will create highly energy efficient dwellings.

5.11 High efficiency SEDBUK ‘A’ rated boilers will be installed in accordance with best practice. These systems have at least an 89% efficiency rating (SAP 2009) and are suited to the size of the dwellings.

5.12 The Boilers will be fitted with a weather compensator which maintains temperature inside the dwelling in relation to the outside temperature. This senses when heat is required and reduces the demand for unwanted heat.

Limiting the Risk of Summer Overheating

5.13 Minimising the risk of summer overheating is important so as to ensure that homes are adapted to climate change and remain comfortable to occupy in the future. An illustrative strategy is presented here that enables dwellings to pass the overheating test. The Applicant commits to ensuring that all dwellings will not have a high risk of summer overheating and will adopt appropriate measures to ensure this is delivered.

5.14 In line with the Cooling Hierarchy within London Plan Policy 5.9, it is proposed to reduce the need for active cooling as far as possible and will remove the requirement for the installation of mechanical cooling. All homes will therefore be subject to measures to minimise the risk of summer overheating to an acceptable level.

5.15 This will be done through the specification of non-mechanical measures such as good thermal insulation and air tightness.

5.16 Additionally, solar control glazing (low g-value) will be installed to reduce solar heat gains. An initial SAP Appendix P overheating risk assessment has been performed on representative sample homes. This assessment has concluded that glazing with a g-value of 0.50 or less should be used, with a g-value of 0.30 in the heavily glazed penthouse apartments.

5.17 In addition to the measures applied to each dwelling, cooling will be facilitated on a community scale through measures which encourage evapotranspiration - energy which would otherwise heat the local atmosphere is instead used to evaporate water. Both these measures help to reduce the urban heat island effect.

5.18 Open-able windows will be used across the Proposed Development and will enable cross-ventilation (all the dwellings are at least dual aspect), convective-ventilation and night purging. These concepts are illustrated in Figure 4 and will reduce the build-up of heat within homes.

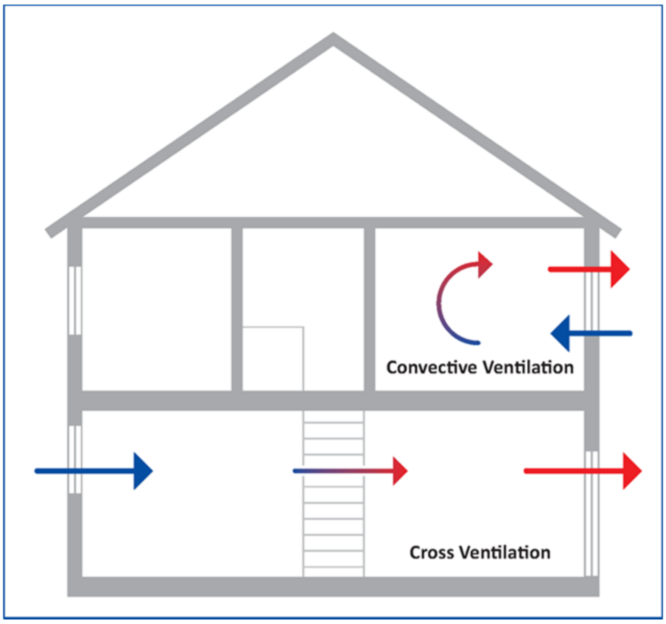

Figure 4: Natural Ventilation

5.19 The SAP overheating assessments that have been undertaken on the sample home types show that there is not expected to be a high risk of summer overheating.

Lighting and Appliances

5.20 Energy efficient lighting will be installed in 100% of internal fittings in the homes. External lighting will also be low energy lighting and controlled through PIR sensors, or daylight cut-off devices. Kitchen and other pre-installed appliances will be A or A+ rated for energy efficiency.

5.21 It is very difficult to design and construct homes to reduce the unregulated electricity demands, because this is almost entirely dependent on the occupant of a home and can vary substantially.

5.22 However, the Applicant is committed to ensuring that all efforts are made to enable the residents to minimise their unregulated electricity consumption. Advice will be provided to all occupants in the form of a Home User Guide on how to minimise electricity consumption. This includes advice on purchasing low-energy devices as well as ensuring that they are used efficiently. It has been shown that the provision of such information can significantly reduce energy use.

CO_2 Emissions Following Be Lean Measures

5.23 The impact of the above measures on the site-wide Regulated & Total CO_2 emissions of the Proposed Development is shown in Table 3, below. It is evident that the measures detailed above enable 2013 Building Regulations to be achieved for the site as a whole through energy efficiency measures alone. A summary of the SAP calculations for the baseline and **Be Lean** cases are presented in Appendix B. Full SAP DER worksheets for the representative units types assessed are presented in Appendix C.

Table 3: BE LEAN Carbon Dioxide Emissions		
	Carbon dioxide emissions ($kgCO_2$.a)	
	Regulated	TOTAL
TOTAL	23,753	47,389
CO_2 Reduction from Baseline	950	950
% Reduction	**4%**	**2%**

5.24 The Dwelling Fabric Energy Efficiency (DFEE) result is a good indicator of the energy efficiency of new homes. The block area weighted average result of the representative dwellings modelled in SAP is 47.5 kWh/m^2/year, compared to the Target Fabric Energy Efficiency (TFEE) result of 51.4kWh/m^2/year (see Table 4). This is a 7.5% improvement, surpassing Part L 2013 requirements and representing a high level of fabric energy efficiency.

Table 4: Dwelling Fabric Energy Efficiency						
Dwelling Type	No. Dwellings	Unit Floor Area (m^2)	TOTAL Floor Area (m^2)	DFEE (kWh/m^2/yr)	TFEE (kWh/m^2/yr)	DFEE Improvement Over TFEE
Ground Floor 2-bed	3	69	208	60.67	64.71	6.24%
Mid Floor 1-bed	6	52	312	43.38	48.41	10.39%
Mid Floor End 2-bed	5	66	331	42.02	47.45	11.44%
Mid Floor Mid 2-bed	4	60	242	32.95	40.77	19.18%
Top Floor 3-bed	2	110	220	65.38	60.62	-7.85%
AREA WEIGHTED AVERAGE				**47.54**	**51.39**	**7.5%**

6. BE CLEAN: DECENTRALISED ENERGY

6.1 In line with Policy 5.6 of the London Plan, the feasibility of decentralised heating networks as a **Be Clean** measure has been evaluated. This is the next step in the Energy Hierarchy after **Be Lean**. The London Plan outlines the following order of preference: -

> Connection to existing heating or cooling networks;

> Site wide CHP network;

> Communal heating and cooling.

6.2 The inclusion of decentralised heating has been investigated in terms of appropriateness to the Proposed Development, and, to be in line with the priorities for this energy strategy, whether decentralised heating is the best technology to provide the greatest reductions in CO_2 emissions.

6.3 As shown in Figure 5, there is no existing or proposed district heating schemes in proximity to the site in to which the development could connect.

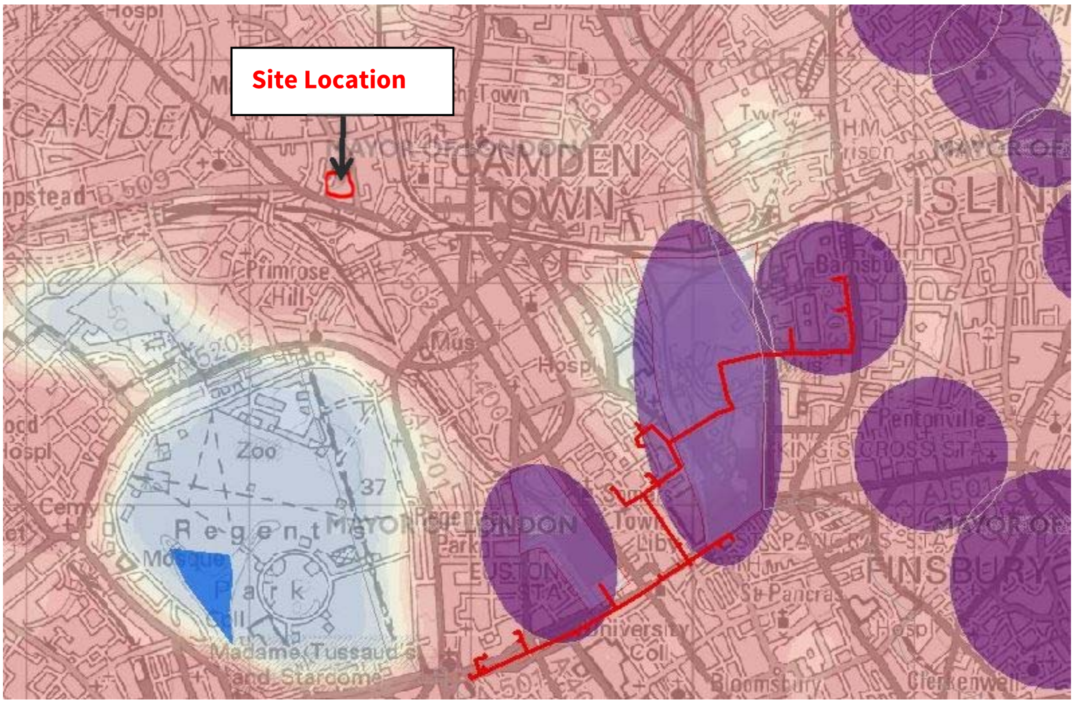

Figure 5: London Heat Map showing no existing or proposed district heat network in close proximity to the site (purple areas indicate future potential opportunity areas only)

6.4 Small Combined Heat and Power (CHP) engines are much less efficient than larger ones, having a worse heat to power ratio. This means that they do not enable as large a CO_2 reduction as for a larger development, which would be able to utilise a larger and more efficient CHP engine. GLA guidance published in April 2014 states that it is not expected, for smaller sites (less than 300 dwellings) to carry out a full feasibility analysis for the use of CHP.

6.5 Communal heating is most suitable on larger developments, where advantage can be taken from economies of scale. This is true both in capital cost and operational cost. As an example the cost of gas boilers for a 100 home development would be less than double that for a 50 home scheme. This increases the cost per home for a small scheme such as this. With regard to operational costs, the same is true – the maintenance of a plant room for a 100 home scheme would be similar to that for a 50 home scheme. The cost per home is therefore double for a small scheme. This additional cost would be passed to residents in their heat bills.

6.6 Therefore, it is not feasible to connect into a district heating network and it would not be economically or socially sustainable for a communal heat network to be provided for this development due to its small nature.

7. BE GREEN: RENEWABLE ENERGY TECHNOLOGIES

7.1 The final part of the London Plan Energy Hierarchy is **Be Green** which seeks for renewable energy technologies to be specified to provide, where feasible, a reduction in expected carbon dioxide emissions (Policy 5.7).

7.2 Further details on the renewable energy technologies discussed in this section can be found in Appendix A. Appendix D provides a feasibility study table of the technologies that have been considered.

Solar Thermal Panels

7.3 Solar thermal panels generate heat for hot water. The benefits of solar thermal panels are constrained by the seasonal variation in solar radiation. This means that solar thermal panels can only deliver a maximum of 60% of the annual hot water demand.

7.4 Whilst technically viable, there are a number of reasons why solar thermal panels are not the favoured technology for this development:

- Need for hot water cylinders in each home – it is likely that due to the size of the units most are best served with combination boilers. Cylinders would reduce internal space;
- The CO_2 reduction possible is constrained by the hot water demand;
- Higher cost in comparison to solar PV panels.

7.5 Therefore, solar thermal panels are not the preferred technology for the proposed development and are not specified.

Wind Turbines

7.6 Wind turbines would be roof mounted and intended to generate electricity. However, urban wind conditions are generally poor and turbulent, adversely affecting the performance of wind turbines. Before specifying or installing wind turbines extensive analysis of the wind resource at the specific site should be undertaken to ensure that wind conditions are suitable.

7.7 It has been concluded that wind turbines are not the most appropriate renewable energy technology for the Proposed Development. This is due to the expense of the technology itself and the uncertain CO_2 benefit that they would provide. As such they will not be installed.

Biomass Boiler

7.8 Biomass boilers with modern pollution abatement devices such as ceramic filter systems can almost eliminate particulate matter emissions and are also very low on emissions of NO_X.

7.9 However, like CHP engines, biomass boilers require a central plant room and communal heat network. Such a system has been discounted as inappropriate for a development of this size and nature.

Air & Ground Source Heat Pumps (ASHPs & GSHPs)

7.10 ASHPs and GSHPs would generate heat for space heating and hot water. However, GSHPs are a very costly technology which would require boreholes due to the space restrictions on the Application Site. Although less expensive, ASHPs are less efficient than GSHPs.

7.11 Considering the site is capable of supplying mains gas fuelled heating and hot water, a potential heat pump option must be evaluated against the carbon emissions rate of a mains gas fuelled system. The use of electricity is more carbon intensive than mains gas and therefore switching the fuel type would negate the benefits of a heat pump installation. A heat pump system would be more appropriate at sites where a mains gas connection is not easily accessible.

7.12 A heat pump system would not achieve the reduction in carbon emissions required when assessed against a comparable mains gas system. Therefore the technology is not a viable option for the Proposed Development.

Solar Photovoltaic (PV) Panels

7.13 PV panels generate electricity from solar radiation. The generating potential of PV panels is not dependent on development demand, but only on available roofspace for installation and ensuring that they are not overshaded. For this reason and their current low cost, it has been concluded that PV panels are the most appropriate renewable energy technology for this development.

7.14 In accordance with Camden Policy and Guidance, the applicant has included extensive green roofs which will significantly reduce the surface water run-off from the development and creates a Sustainable Urban Drainage System. Its presence will minimise the strain on the traditional drainage network thus consequently reducing the risk of flooding in the local area and further afield. However, the presence of green roofs conflicts with the application of solar PV. The applicant therefore proposes two alternative scenarios as detailed below.

Scenario 1: Green Roofs and Carbon Offsetting Payment (No Solar PV)

7.15 In line with Camden Borough Council Policy and Guidance, the applicant is proposing to install green roofs on the development. This, however, conflicts with the application of solar PV.

7.16 The overall energy strategy measures employed (*Be* Lean only) will therefore result in a 4**%** reduction in regulated CO_2 emissions and 2**%** reduction in total (including unregulated) CO_2 emissions over the Part L 2013 baseline, as demonstrated in Table 5.

Table 5: SCENARIO 1: Carbon Dioxide Emissions Savings after each stage of the energy hierarchy				
	Regulated Carbon Dioxide Savings		Total Carbon Dioxide Savings	
	($kgCO_2$.a)	(%)	($kgCO_2$.a)	(%)
Savings from Be Lean (energy demand reduction)	950	4%	950	2%
Savings from Be Clean (CHP)	0	0%	0	0%
Savings from Be Green (Solar PV)	0	0%	0	0%
Total Cumulative Savings	950	4%	950	2%

7.17 Since CO_2 savings are therefore only achievable from *Be Lean* measures, the overall energy strategy results in an annual shortfall of 31% (equivalent to 7.7 tonnesCO_2/yr) from the London Plan 35% CO_2 reduction requirement. In line with the 'Greater London Authority guidance on preparing energy assessments (April 2014), a £60/tonne carbon abatement cost has therefore been applied to the annual shortfall for a period of 30 years.

7.18 As demonstrated in Table 6, it is calculated that the development should thus contribute £13,853.

Table 6: Carbon Abatement Cost Calculations

Total Cumulative Savings (tonnes CO_2/yr)	Total Target Savings to meet London Plan 35% CO_2 Reduction (tonnes CO_2/yr)	Annual Shortfall CO_2 Emissions (tonnes CO_2/yr)	Carbon Abatement Cost (£/Tonne CO_2)	Development Lifetime (years)	Carbon Abatement Cost for Development CO_2 Emissions
0.95	**8.65**	**7.70**	**£60**	**30**	**£13,853**

Scenario 2: Solar PV and No Green Roofs

7.19 There is sufficient space for the application of approximately 106m^2 solar PV panels on the roof of the development.

7.20 Assuming solar PV panels are orientated facing south and tilted at 20 degrees from horizontal, it is estimated that 16.5kWp could be installed on-site, achieving a saving of 7,690kgCO_2.a as demonstrated in Table 7 (SAP 2012 compliant PV calculation).

Table 7: Solar PV Calculation	
Roof area available	106m^2
Solar PV	16.5 kWp
Solar Radiation*	1,120 kWh/m^2/yr
Energy Generation	14,820 kWh/yr
CO_2 Emissions Saving	7,690 kg CO_2/yr

**Assuming southerly orientation and 20 degrees tilt from horizontal*

7.21 Table 8 shows that the specified PV panels reduce Regulated CO_2 emissions by a further 32% and 16% in regulated and total CO_2 emissions respectively after the application of ***Be Lean*** measures. The combination of **Be Lean** and **Be Green** measures will result in a **35%** reduction in regulated CO_2 emissions and **18%** reduction in total (including unregulated) CO_2 emissions over the Part L 2013 baseline.

Table 8: SCENARIO 2: Carbon Dioxide Emissions Savings after each stage of the energy hierarchy				
	Regulated Carbon Dioxide Savings		Total Carbon Dioxide Savings	
	(kgCO_2.a)	(%)	(kgCO_2.a)	(%)
Savings from Be Lean (energy demand reduction)	950	4%	950	2%
Savings from Be Clean (CHP)	0	0%	0	0%
Savings from Be Green (Solar PV)	7,693	32%	7,693	16%
Total Cumulative Savings	**8,642**	**35%**	**8,642**	**18%**

8. SUMMARY

8.1 The Energy Strategy for the Proposed Development has been formulated following the London Plan Energy Hierarchy**: Be Lean**, **Be Clean** and **Be Green**. The overriding objective in the formulation of the strategy is to maximise the reductions in CO_2 emissions through the application of this Hierarchy with a cost-effective, viable and technically appropriate approach and to minimise the emission of other pollutants.

8.2 The Site will be built under Part L 2013 of the Building Regulations; therefore, in line with the London Plan, will target a 35% CO_2 reduction over the Part L 2013 baseline.

8.3 A range of advanced ***Be Lean*** energy efficiency measures are proposed. They enable the proposed development to exceed Part L1A 2013 Target Emission Rate (TER) and Target Fabric Energy Efficiency (TFEE) minimum standards for the residential aspect of the development through energy efficiency measures alone. A site-wide **4%** and **2%** reduction in regulated and total CO_2 emissions respectively is predicted over the Part L 2013 baseline. This represents a high level of sustainable design and construction.

8.4 In line with the London Plan, the feasibility of decentralised energy production as a **Be Clean** measure has been assessed. There are currently no existing or proposed district heat networks in the area. It has been concluded that a communal heating strategy is inappropriate for a development of this size as it would substantially increase capital costs and operational costs (and resident energy bills).

8.5 The full spectrum of **Be Green** renewable energy generating technologies has been considered. PV panels are considered the most appropriate but conflicts with the proposed green roofs on the development which are a Camden council preference. The applicant has therefore explored two scenarios:

- **Scenario 1: Green Roofs and Carbon Offsetting Payment (no solar PV)** - The overall energy strategy measures employed (*Be* Lean only) will result in a 4**%** reduction in regulated CO_2 emissions and 2**%** reduction in total (including unregulated) CO_2 emissions over the Part L 2013 baseline. A carbon offsetting cost of £13,853 will therefore be paid to Camden Borough Council. This strategy complies with the London Plan, Code for Sustainable Homes Level 3 mandatory energy credits and Camden Borough Council policies.

- **Scenario 2: Solar PV but No Green Roofs** – 16.5kWp solar PV will be installed instead of green roofs to achieve an estimated further regulated and total CO_2 emission reduction of **32%** and **16%** after **Be Lean** emissions. The combination of **Be Lean** and **Be Green** measures will result in a **35%**

reduction in regulated CO_2 emissions and **18%** reduction in total (including unregulated) CO_2 emissions over the Part L 2013 baseline. This strategy complies with the London Plan, Code for Sustainable Homes Level 4 mandatory energy credits and Camden Borough Council policies.

8.6 The applicant seeks guidance from Camden Borough Council on which strategy they would favour taking forward.

APPENDICES

Appendix A
Low Carbon & Renewable Energy Technologies

Appendix B
SAP CO_2 Baseline and Be Lean Calculations

Appendix C
SAP DER Worksheets

Appendix D
Feasibility Table of Low Carbon & Renewable Energy Technologies

APPENDIX A: LOW CARBON AND RENEWABLE ENERGY TECHNOLOGIES

INTRODUCTION

> This Appendix is intended to provide the background information for the low carbon and renewable energy technologies that have been considered in the formulation of this Energy Statement.

> The information provided here forms the basis for the project specific technical selection of low carbon/renewable energy technologies contained in the main section of this Energy Statement.

COMBINED HEAT AND POWER (CHP)

> CHP is a form of decentralised energy generation that generally uses gas to generate electricity for local consumption, reducing the need for grid electricity and its associated high CO_2 emissions. As the CHP system is close to the point of energy demand, it is possible to use the heat that is generated during the electricity generation process. As both the electricity and heat from the generator is used, the efficiency of the system is increased above that of a conventional power plant where the heat is not utilised.

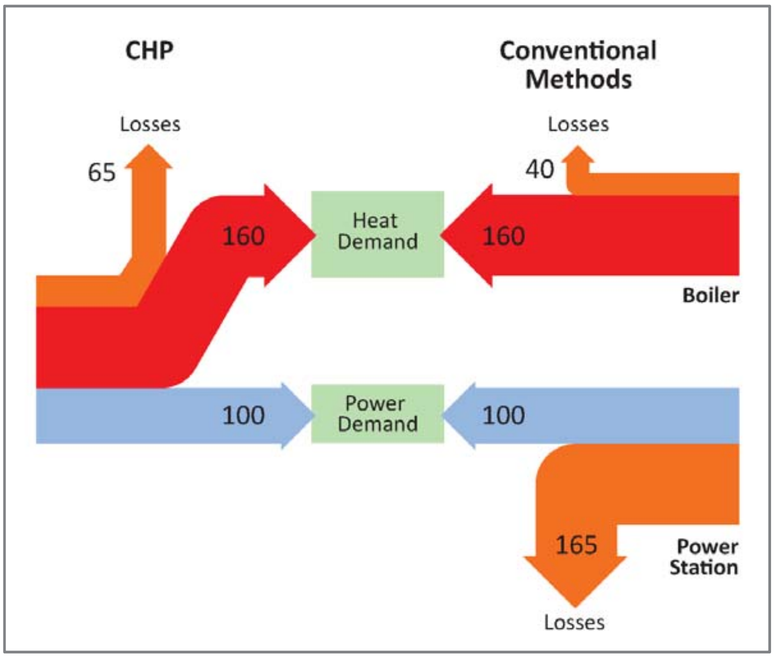

Diagram 1 – CHP Diagram

> However, the overall efficiency of ~80% is still lower than the ~90% efficiency of a heat only gas boiler.

- Where there are high thermal loads, CHP can be used within district heating networks to supply the required heat.
- **Performance and Calculation Methodology: -**
  - Most commonly sized on the heat load of a development, not the electrical load. This prevents an over-generation of heat.
  - Require a high and relatively constant heat demand to be viable.
  - CHP engines are best suited to providing the base heating load of a development (~year round hot water demand) with conventional gas boilers responding to the peak heating demand (~winter space heating). CHP engines are not able to effectively respond to peaks in demand.
  - In general, CHP engines have an electrical efficiency of ~30% and a thermal efficiency of ~45%. Larger engines have a better heat to power ratio and are therefore able to reduce CO_2 emissions by greater amount.
  - Electricity produced by the CHP engine displaces grid electricity which is given a carbon intensity of 0.519 kg per kWh.
- **Capital Cost: -**
  - Around £1,000 per kW of electrical output.
  - Relative cost reduces as the size of engine increases.
  - Generally best suited to larger sites, where there is a suitable economy of scale.
- **Running Costs/Savings: -**
  - CHP engines often struggle to provide cost-effective energy to dwellings on smaller residential schemes compared to conventional individual gas boilers.
  - Onsite use of CHP generated electricity; power Purchase Agreement with electricity Supply Company or Private Wire arrangement to local large non-domestic demand enhances economic case.
- **Land Use Issues and Space Required: -**
  - CHP engines require a plant room, and possibly an energy centre for large residential developments.
  - CHP engines require a flue to effectively disperse pollutants. This is best to rise to a minimum of 2m above the roofline of the tallest building.
  - Route for district heating pipe around the site must be safeguarded.
- **Operational Impacts/Issues: -**
  - Often run by Energy Services Company (ESCo) who maybe unenthusiastic about getting involved in small – medium scale schemes.

> Can also be run in-house with specialist maintenance and customer services activities contracted out.

> Issues with rights to dig up roads for district heating networks.

> Emissions of oxides of nitrogen – ~500mg/kWh – 10 times higher than for a gas boiler. Specialist technologies exist (e.g. selective catalytic reduction) to reduce this to ~20mg/kWh if air quality issues require.

- **Embodied Energy:** - Comparable to that of a conventional gas boiler.
- **Funding Opportunities: -**
  - Tax relief for businesses under the Enhanced Capital Allowances scheme.
- **Reductions in Energy Achievable: -** Can provide some reductions in effective primary energy, but when distribution losses and other local losses are included more fuel is required.
- **Reductions in CO_2 Achievable: -** Can provide greater reductions in CO_2 than energy, aided by the emissions factor of grid displaced electricity of 0.519 kg CO_2/kWh. CO_2 reduction increase as size of engine increases.
- **Advantages: -**
  - Good reductions in overall primary energy and CO_2 emissions.
  - Most cost effective and appropriate strategy to achieve substantial CO_2 reductions on large schemes.
- **Disadvantages: -**
  - On smaller schemes often do not supply energy cost-effectively in comparison to conventional individual gas boilers.
  - Requires sale of generated electricity to maximise cost effectiveness.

Application:- Best suited to larger developments.

COMBINED COOLING HEAT AND POWER (CCHP)

- CCHP is a CHP system which additionally has the facility to transform heat into energy for cooling. This is done with an absorption chiller which utilises a heat source to provide the energy needed to drive a cooling system. As absorption chillers are far less efficient than conventional coolers (CoP of 0.7 compared to >4) they are generally only used where there is a current excess generation of heat. New CHP systems are generally sized to provide the year round base heating load only.

- For this reason it is generally not suitable for new CHP systems to include cooling.
- Where there are high thermal loads, CCHP can be used within district heating and cooling networks to supply the required heat and coolth.
- **Performance and Calculation Methodology: -**
  - Most commonly sized on the heat load of a development, not the electrical load. This prevents an over-generation of heat.
  - Require a high and relatively constant heat and cooling demand to be viable.
  - CCHP systems are best suited to providing the base loads of a development with conventional gas boilers and chillers responding to the peak demands. CCHP systems are not able to effectively respond to peaks in demand.
  - In general, CHP engines have an electrical efficiency of ~30% and a thermal efficiency of ~45%.
  - Absorption chillers have a CoP of ~0.7.
  - Electricity produced by the CHP engine displaces grid electricity which is given a carbon intensity of 0.519 kg per kWh.
- **Capital Cost: -**
  - High in comparison to biomass boilers and increased further by inclusion of absorption chiller.
- **Running Costs/Savings: -**
  - Coolth from absorption chillers is more expensive than from conventional systems unless heat used id genuine waste heat.
- **Land Use Issues and Space Required: -**
  - CCHP systems require a plant room, and possibly an energy centre for large residential developments.
  - CHP engines require a flue to effectively disperse pollutants. This is best to rise to a minimum of 2m above the roofline of the tallest building. Additionally the absorption chiller requires either a cooling tower or dry cooler bed for heat rejection purposes.
  - Heating and cooling distribution pipework required around the site.
- **Operational Impacts/Issues: -**
  - Often run by an ESCo who are unenthusiastic about getting involved in small – medium scale schemes.
  - Can also be run in-house with specialist maintenance and customer services activities contracted out.

  - > Issues with rights to dig up roads for heat networks.
  - > Emissions of oxides of nitrogen– ~500mg/kWh – 10 times higher than for gas boilers. Specialist technologies exist (e.g. selective catalytic reduction) to reduce this ~20mg/kWh if air quality issues require.
  - > Rejection of heat is higher than for conventional cooling, thus enforcing the urban heat island effect.
  - > Embodied Energy: - Comparable to conventional gas boilers.

> **Funding Opportunities: -**

  - > Tax relief for businesses under Enhanced Capital Allowance scheme.
  - > Reductions in Energy Achievable: - Absorption cooling generally requires more energy than conventional chillers.
  - > Reductions in CO_2 Achievable: - Can provide greater reductions in CO_2 than energy, aided by the emissions factor of grid displaced electricity of 0.519 kg CO_2/kWh.

> **Advantages: -**

  - > Reasonable reductions in overall primary energy and CO_2 emissions.
  - > Disadvantages: - More expensive to install than conventional chillers.
  - > Operational costs higher than for conventional chillers.

> **Application: -** Best suited where there is genuine waste heat available.

BIOMASS BOILERS

> Biomass boilers generate heat on a renewable basis as they are run on biomass fuel which is almost carbon neutral. Fuel is generally wood chip or wood pellets. Wood pellets are slightly more expensive than wood chips but have a significantly higher calorific value and enable greater automation of the system.

> Various other suitable fuels are available including organic materials including straw, dedicated energy crops, sewage sludge and animal litter. Each fuel tends to have its own advantages dependant on site requirements.

> Can be used with district heating networks or as individual boilers on a house-by-house basis.

> **Performance and Calculation Methodology: -**

  - Biomass boilers are best suited to providing the base heating load of a development (~year round hot water demand) with conventional gas boilers responding to the peak heating demand (~winter space heating).
  - Operate with an efficiency of around 90%.
  - Small models available.
  - Conflicts with CHP they are both best suited to providing the base heating load of a development. As such they should not be installed in tandem unless surplus hot water capacity is available. Special control measures would be required in this case.
- **Capital Cost: -**
  - Low in comparison to CHP.
  - More suitable to smaller developments than CHP as installed cost is lower.
- **Running Costs/Savings: -**
  - Biomass fuel is more expensive than gas and as such heat being provided to dwellings is generally more expensive than alternatives.
- **Land Use Issues and Space Required: -**
  - Biomass boilers require a plant room and possibly separate energy centre for large residential developments.
  - Require a flue to effectively disperse pollutants. This is best to rise to a minimum of 2m above the roofline of the tallest building. Additionally the absorption chiller requires either a cooling tower or dry cooler bed for heat rejection purposes.
  - Fuel store will be required. This should be maximised to reduce fuel delivery frequency.
  - Space must be available for delivery vehicle to park close to plant room.
  - Route for district heating pipe around the site must be safeguarded.
- **Operational Impacts/Issues: -**
  - Normally run on biomass, but can also work with biogas.
  - Require some operational support and maintenance.
  - Fuel deliveries required.
  - Boiler and fuel store must be sited in proximity to space for delivery vehicle to park.
  - Issues with rights to dig up roads, etc (for heat networks).
  - Emissions of oxides of nitrogen – ~80-100mg/kWh.
  - Emissions of particulate matter. To minimise this ceramic filter systems are required.
  - Embodied Energy: - Comparable to conventional gas boiler.

> **Funding Opportunities: -**

> Renewable Heat Incentive (RHI) provides incentive funds to developers of small or medium installations with a reasonable heat load that meet a minimum energy efficiency standard & meet the RHI eligibility criteria.

> Reductions in Energy Achievable: - No reduction in energy demand, but energy generated from a renewable fuel. Significant long term running costs (fuel).

> Reductions in CO_2 Achievable: - Can provide significant reductions in CO_2, but generally limited by the hot water load (base heating load).

> Advantages: - Reductions in CO_2 at low installed cost.

> **Disadvantages: -**

> High long-term running costs, unless receiving RHI.

> Often do not supply energy cost-effectively in comparison to gas boilers.

SOLAR THERMAL PANELS

> Solar Thermal Heating Systems contribute to the hot water demand of a dwelling or building. Water or glycol (heat transfer fluid) is circulated to roof level where it is heated using solar energy before being returned to a thermal store in the plant room where heat is exchanged with water from the conventional system. Due to the seasonal availability of heat, solar thermal

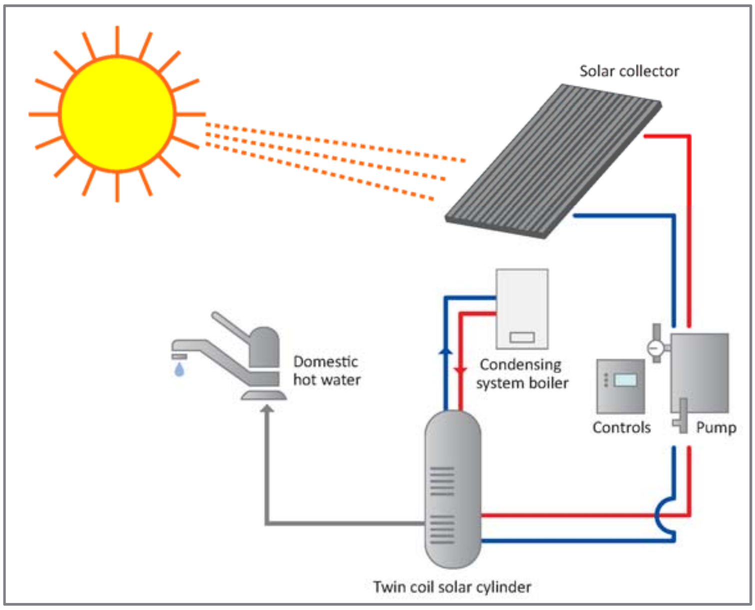

Diagram 2 – Solar Thermal System

panels should be scaled to provide no more than 1/2 of the hot water load.

- Can also be used to provide energy for space heating in highly insulated dwellings.
- There are two types of solar thermal panel: evacuated tube collectors and flat plate collectors.
- **Performance and Calculation Methodology: -**
  - Evacuated Tube Collectors: ~60% efficiency.
  - Flat Plate Collectors: ~50% efficiency.
  - SAP Table H2 used for solar irradiation at different angles.
  - Operate best on south facing roofs angled at 30-450 and free of shading, or on flat roofs on frames. East/West facing panels suffer a loss in performance of 15-20% depending on the angle of installation.
  - Flat plate collectors cannot be installed horizontally as this would prevent operation of the water pump. Must therefore be angled and separated to avoid overshadowing each other.
- **Capital Cost: -** Typically £2,500 per 4m^2 plus installation. Costs higher for evacuated tubes than flat plate collectors.
- **Running Costs/Savings: -**
  - Reduce reliance on gas and therefore reduce costs.
  - Payback period of ~20 years per dwelling.
- **Land Use Issues and Space Required: -**
  - Installed on roof so no impact on land use.
  - Requires hot water cylinders in dwellings.
  - Due to amount of roof space required and distance from tank to panels, less suitable for dense developments of relatively high rise flats.
  - Within permitted development rights unless in a conservation area where they must not be visible from the public highways.
  - Dormer and Velux windows may conflict if energy/CO_2 reduction required is large.
- **Operational Impacts/Issues:** - Biggest reductions achieved by people who operate their hot water system with consideration of the panels.
  - Embodied Energy: - Carbon payback is ~2 years.
  - Funding Opportunities: - none
- **Reductions in Energy Achievable:** - Reduce primary energy demand by more per standard panel area than solar PV panels.
  - Reductions in CO_2 Achievable: - Comparable to solar PV per m^2.

- **Advantages: -** Virtually free fuel, low maintenance and reductions in energy/CO_2.
- **Disadvantages: -** Benefits limited to maximum ~50% of hot water load.
  - Higher Costs in comparison to PV
- **Application: -** Best suited for small to medium housing developments ~1-100

SOLAR PHOTOVOLTAIC (PV) PANELS

- Solar PV panels generate electricity by harnessing the power of the sun. They convert solar radiation into electricity which can be used on site or exported to the grid in times of excess generation.
- **Performance and Calculation Methodology: -**
  - The best PV panels operate with an efficiency approaching 20%. ~7m^2 of these high performance panels will produce 1kWp of electricity.
  - Operate best on south facing roofs angled at 30-450 or on flat roofs on frames. Panels orientated east/west suffer from a loss in performance of 15-20% depending on the angle of installation.
  - Must be free of any potential shading.
  - Cannot be installed horizontally as would prevent self-cleaning. Must therefore be angled and separated to avoid overshadowing each other.
  - Electricity produced displaces grid electricity which has a carbon intensity of 0.519 kg CO_2 per kWh.
- **Capital Cost:** - ~£2,000 per kWp.
- **Running Costs/Savings: -**
  - Reduce reliance on grid electricity and therefore reduce running costs.
  - At current electricity prices, payback period of ~60-70 years per dwelling.
  - Feed-in tariff and Renewables Obligation Certificates (ROCs) payments required for maximum financial benefit.
- **Land Use Issues and Space Required: -**
  - Installed on roof so no impact on land use.
  - Due to amount of roof space required are less suitable for dense developments of relatively high rise flats.

    - Within permitted development rights unless in a conservation area where they must not be visible from the public highways.
    - Dormer and Velux windows may conflict if energy/CO_2 reduction required is large.
- **Operational Impacts/Issues: -**
    - Proportionately large arrays may need electrical infrastructure upgrade.
    - Virtually maintenance free and panels are self-cleaning at angles in excess of 10 degrees.
    - Provision for access to solar panels installed on flat roofs needs to be incorporated into the design of PV arrays layout as well as inclusion of spaces for inverters within the development.
    - Quality of PV panels varies dramatically.
- **Embodied Energy: -** Carbon payback of 2-5 years.
- **Funding Opportunities: -** Financier utilising Feed-in-Tariffs.
- **Reductions in Energy Achievable:** - Reduce energy demand by less per m^2 than solar thermal panels.
- **Reductions in CO_2 Achievable:** - Provide greater percentage reductions in CO_2 than energy. Comparable to solar thermal per square metre.
- **Advantages: -** Virtually free fuel, very low maintenance and good reductions in CO_2.
    - Cheaper in comparison to solar thermal panels.
- **Disadvantages: -**
    - Slightly greater loss in performance than solar thermal panels when orientated away from south.
- **Application:** Best suited for a variety of developments from single houses to multi apartment blocks and even whole estates.

GROUND SOURCE HEAT PUMPS (GSHPS)

> Ground Source Heat Pumps work in much the same way as a refrigerator, converting low grade heat from a large 'reservoir' into higher temperature heat for input in a smaller space. Electricity drives the pump which circulates a fluid (water/antifreeze mix or refrigerant) through a closed loop of underground pipe. This fluid absorbs the solar energy that is stored in the earth (which in the UK remains at a near constant temperature of 12oC throughout the year) and carries it to a pump. A compressor in the heat pump upgrades the temperature of the fluid which can then be used for space heating and hot water.

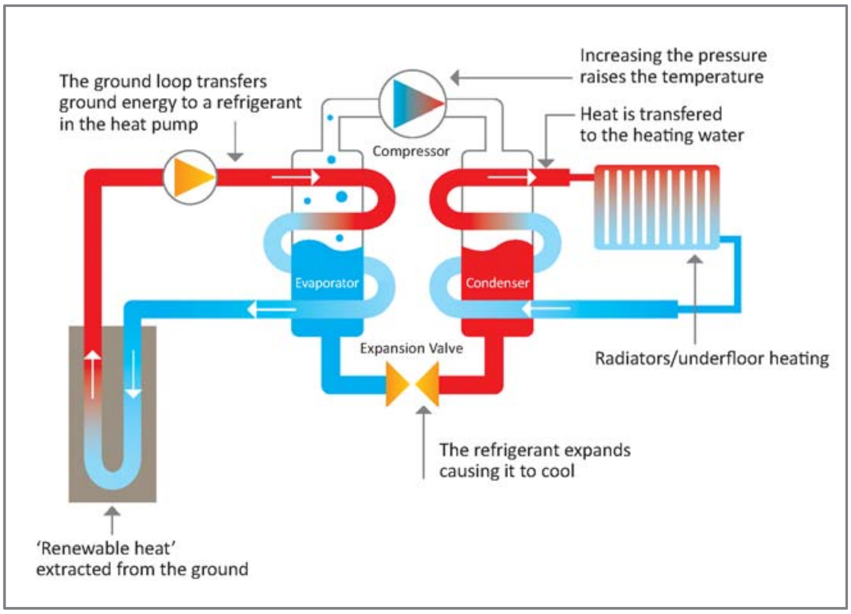

Diagram 3 – Ground Source Heat Pump

> **Performance and Calculation Methodology: -**

> System requires electricity to drive the pump. Therefore displaces gas heating with electric, which has higher carbon intensity (gas: 0.216; electricity: 0.519).

> As they are upgrading heat energy from the earth, GSHPs operate at 'efficiencies' in excess of 350%. This is limited in SAP unless Appendix Q rated model used.

> Due to the lower temperature of the output of GSHPs compared to traditional gas boilers, GSHPs work best in well insulated buildings and with underfloor heating. They can, however, also be installed with oversized radiators, albeit with a consequent reduction in performance.

> **Capital Cost: -** ~£7,500 per house. Additional costs if underfloor heating is to be installed.

- **Running Costs/Savings: -**
    - Electricity more expensive than gas, thus fuel costs not reduced as much as energy is reduced.
    - Payback period of ~20 years per dwelling.
- **Land Use Issues and Space Required: -**
    - Require extensive ground works to bury the coils that extract the low grade heat from the earth. They therefore require a large area for horizontal burial (40-100m long trench) or a vertical bore (50-100m) which is considerably more expensive but can be used where space is limited.
    - Best suited to new developments that have provision for large ground works already in place, to minimise ground work costs.
    - Must be sized correctly to prevent freezing of the ground during winter and consequent shutdown of the system.
    - May require planning permission for engineering works. Once buried, there is no external evidence of the GSHPs.
- **Operational Impacts/Issues: -**
    - Work best in well insulated houses.
    - Need immersion backup for hot water.
    - Highly reliable and require virtually no maintenance.
    - Problems if ground bore fails.
- **Embodied Energy:** - Low, but as gas is being replaced with the more carbon intensive electricity, carbon payback is slowed. Carbon payback depends on CoP.
- **Funding Opportunities:** - Renewable Heat Incentive (RHI) provides incentive funds to developers of small or medium installations with a reasonable heat load that meet a minimum energy efficiency standard & meet the RHI eligibility criteria.
- **Reductions in Energy Achievable:** - Reduce energy demand by less per m^2 than solar thermal panels.
- **Reductions in CO_2 Achievable: -** Provide greater %age reductions in CO_2 than energy. Comparable to solar thermal (esp. in SAP).
- **Advantages:** - Large reductions in Energy. Currently receives benefit from SAP of an electrical baseline rather than gas.
- **Disadvantages: -**
    - Small reduction in CO_2. CoP limited in SAP. Only small cost savings.

> GSHPs are not entirely a 'renewable' technology as they require electricity to drive their pumps or compressors.

> **Application: -** Best suited for small to medium developments ~1-100

AIR SOURCE HEAT PUMPS (ASHPS)

> Air Source Heat Pumps work in much the same way as a refrigerator, converting low grade heat from a large 'reservoir' into higher temperature heat for input into a smaller space. Electricity drives the pump which extracts heat from the air as it flows over the coils in the heat pump unit. A compressor in the heat pump upgrades the temperature of the extracted energy which can then be used for space heating and hot water.

> Generally ASHPs are air-to-water devices but can also be air-to-air.

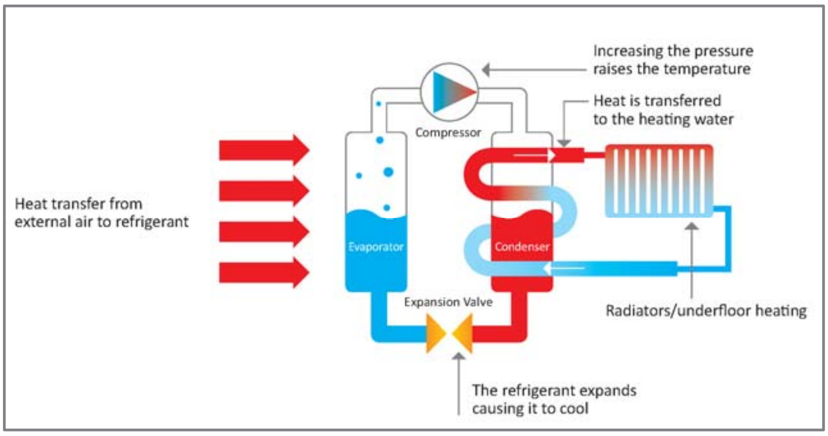

Diagram 4 – Air Source Heat Pump

> **Performance and Calculation Methodology: -**

> System requires electricity to drive the pump. Therefore displaces gas heating with electric, which has higher carbon intensity (gas: 0.216; electricity: 0.519).

> Performance defined by the Coefficient of Performance (CoP) which is a measure of electricity input to heat output. However, the concept of a CoP must be treated with

caution as it is an instantaneous measurement and does not take account of varying external conditions throughout the year.

    - As they are upgrading heat energy from the air, ASHPs operate at 'efficiencies' in excess of 250%. This is limited in SAP unless an Appendix Q rated model is used.
    - British winter conditions (low temperatures and high humidity) lead to freezing of external unit. Reverse cycling defrosts the ASHP, but can substantially reduce performance when it is most needed. Performance under these conditions varies considerably between models. Vital that ASHP that has been proven in British winter conditions is installed.
    - Due to the lower temperature of the output of ASHPs compared to traditional gas boilers, ASHPs work best in well insulated buildings and with underfloor heating. They can, however, also be installed with oversized radiators, albeit with a consequent reduction in performance.
- **Capital Cost: -** ~£2,000 per house.
- **Running Costs/Savings: -**
    - Electricity more expensive than gas, thus fuel costs not reduced as much as energy is reduced.
    - Payback period of ~10 years per dwelling.
- **Land Use Issues and Space Required: -**
    - No need for external ground works, only a heat pump unit for the air to pass through.
    - Minimal external visual evidence.
- **Operational Impacts/Issues: -**
    - Work best in well insulated houses.
    - Unit must be sized correctly for each dwelling.
    - Vital that ASHP model selected has been proven to maintain performance at the low temperature and high humidity conditions of the British winter.
    - May need immersion backup for hot water.
    - Highly reliable and require virtually no maintenance.
    - Noise from ASHPs must be below 42 dB at a position one metre external to the centre point of any door or window in a habitable room. According to planning standards MCS020.
- **Embodied Energy:** - Low. Carbon payback longer than for GSHPs as the CoP is lower.
- **Funding Opportunities:** - Renewable Heat Incentive (RHI) provides incentive funds to developers of small or medium installations with a reasonable heat load that meet a minimum energy efficiency standard & meet the RHI eligibility criteria.

- **Reductions in Energy Achievable: -** Large reductions in energy demand. Less so than GSHPs.
- **Reductions in CO_2 Achievable: -** Provide smaller percentage reductions in CO_2 than energy. Less than GSHPs.
- **Advantages: -** Large reductions in Energy. Currently receives benefit from SAP of an electrical fuel factor rather than a gas baseline.
- **Disadvantages: -**
  - Small reduction in CO_2 CoP limited in SAP. Only small cost savings.
  - ASHPs are not entirely a ‘renewable’ technology as they require electricity to drive their pumps or compressors.
- **Application: -** Best suited for small to medium developments ~1-100

WIND POWER

- Wind energy installations can range from small domestic turbines (1kW) to large commercial turbines (140m tall, 2MW). There are also different designs and styles (horizontal or vertical axis; 1 blade to multiple blades) to suit the location. They generate clean electricity that can be provided for use on-site, or sold directly to the local electricity network
- **Performance and Calculation Methodology: -**
  - Power generated is proportional to the cube of the wind speed. Therefore, wind speed is critical.
  - Horizontal axis turbines require >~6m/s to operate effectively and vertical axis turbines require >~4.5m/s. The rated power of a turbine is often for wind speeds double these figures.
  - Wind speeds for area from BERR’s Wind Speed Database.
  - Electricity produced displaces grid electricity which has a carbon intensity of 0.568 kg/kWh.
- **Capital Cost: -**
  - ~£1,000 per kW. Smaller models are more expensive per kW.
  - Vertical axis turbines more expensive than horizontal.
- **Running Costs/Savings: -**
  - Reduce reliance on grid electricity and therefore reduce costs.
  - Payback period of ~15-20 years per dwelling.

    > Feed-in tariff and ROC payments required for maximum financial benefit.

> **Land Use Issues and Space Required: -**

    > Smaller models (<6kW) can be roof mounted.
    > Must be higher than surrounding structures/trees.
    > Planning permission required.

> **Operational Impacts/Issues: -**

    > Urban environments generally have low wind speeds and high turbulence which reduce the effectiveness of turbines.
    > Vertical axis turbines have a lower performance than horizontal axis turbines but work better in urban environments.
    > Annual services required.
    > Turbines rated in excess of 5kW may require the network to be strengthened and arrangements to be made with the local Distribution Network Operator and electricity supplier.
    > Noise.

> **Embodied Energy: -** Carbon payback is ~1 year for most turbines.

> **Funding Opportunities:** - Financier utilising Feed-in-Tariffs.

> **Reductions in Energy Achievable:** - Significant reduction in reliance on grid electricity.

> **Reductions in CO_2 Achievable: -** Good. Greater reduction in CO_2 than PV for same investment.

> **Advantages: -** Virtually free fuel; reductions in CO_2.

> **Disadvantages: -**

    > Expensive, although cheaper than PV for same return.
    > Lack of suitable sites.
    > Maintenance costs.
    > Often not building integrated.

> **Application:** Best suited for small to large developments in rural open areas.

HYDRO POWER

- Hydro power harnesses the energy of falling water, converting the potential or kinetic energy of water into electricity through use of a hydro turbine. Micro hydro schemes (<100kW) tend to be 'run-of-river' developments, taking the flow of the river that is available at any given time and not relying on a reservoir of stored water. They generate clean electricity that can be provided for use on-site, or sold directly to the local electricity network.
- **Performance and Calculation Methodology: -**
  - Flow rates at particular sites from National River Flow Archive held by Centre for Ecology and Hydrology.
  - Electricity produced displaces grid electricity which has a carbon intensity of 0.568 kg/kWh.
- **Capital Cost: -**
  - £3,000 - £5,000 per kW.
  - Particularly cost effective on sites of old water mills where much of the infrastructure is in place.
- **Running Costs/Savings: -**
  - Reduce reliance on grid electricity and therefore reduce costs.
  - Payback period of ~10-15 years per dwelling
  - Feed-in tariff and ROC payments required for maximum financial benefit.
- **Land Use Issues and Space Required: -**
  - Require suitable water resource.
  - Visual intrusion of scheme.
  - Special requirements where river populated by migrating species of fish.
  - Planning permission will require various consents and licences including an Environmental Statement and Abstraction Licence.
- **Operational Impacts/Issues: -**
  - Routine inspections and annual service required.
  - Automatic cleaners should be installed to prevent intake of rubbish.
- **Embodied Energy: -** Carbon payback for small schemes of ~1 year.
- **Funding Opportunities: -** Financier utilising Feed-in-Tariffs.

- **Reductions in Energy Achievable:** - significant reduction in reliance on grid electricity.
- **Reductions in CO_2 Achievable:** - High.
- **Advantages:** - Virtually free fuel, reductions in CO_2.
- **Disadvantages: -**
    - Expensive, but good payback period.
    - Lack of suitable sites.
    - Planning obstructions.
- **Application: -** Best suited to medium to larger developments in rural places ~ 100+ units

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APPENDIX B: SAP CO_2 BASELINE AND BE LEAN CALCULATIONS

				REGULATED CO2 EMISSIONS					UNREGULATED CO2 EMISSIONS		TOTAL CO2 EMISSIONS				
				BASELINE		ACTUAL			ACTUAL		BASELINE		ACTUAL		
Dwelling Type	No. Dwellings	Unit Floor Area (m2)	TOTAL Floor Area (m2)	TER (kgCO2/m2/yr)	TER *Sq.m (kgCO/yr)	DER (kgCO2/m2/yr)	DER *Sq.m (kgCO/yr)	% DER/TER IMP	Unregulated CO2 Emissions (kgCO2/m2/yr)	Unregulated CO2 Emissions *Sq.m (kgCO/yr)	TOTAL CO2 Emissions (kgCO2/m2/yr)	TOTAL CO2 Emissions *Sq.m (kgCO/yr)	TOTAL CO2 Emissions (kgCO2/m2/yr)	TOTAL CO2 Emissions *Sq.m (kgCO/yr)	% DER/TER IMP
Ground Floor 2-bed	3	69.34	208	21.39	4450	21.25	4,420	0.65%	18	3,744	39	8,194	39	8,165	0.36%
Mid Floor 1-bed	6	52.05	312	19.38	6052	18.43	5,756	4.90%	18	5,621	37	11,674	36	11,377	2.54%
Mid Floor End 2-bed	5	66.22	331	18.18	6019	17.14	5,675	5.72%	18	5,960	36	11,979	35	11,635	2.87%
Mid Floor Mid 2-bed	4	60.42	242	17.52	4234	15.69	3,792	10.45%	18	4,350	36	8,584	34	8,142	5.15%
Top Floor 3-bed	2	110	220	17.94	3947	18.68	4,110	-4.12%	18	3,960	36	7,907	37	8,070	-2.06%
TOTAL	20		1,313		24,702		23,753	3.84%		23,636		48,338		47,389	1.96%

APPENDIX C: SAP DER WORKSHEETS

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	Miss Charlotte Booth	Assessor number	6376
Client	Warmhaze Ltd	Last modified	23/01/2015
Address	20 17-27 & 25 Ferdinand Street, Camden, London, NW1 8EX		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		110.00	(1a)	x	3.10	(2a)	=	341.00	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	110.00	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			341.00	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)
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) =	0.12	(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	0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(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	77.35	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]

0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)

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

0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(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			107.57	x	0.78	=	83.39			(27)
External wall			16.24	x	0.80	=	12.99			(29a)
Party wall			28.64	x	0.00	=	0.00			(32)
Roof			110.00	x	0.10	=	11.00			(30)
Total area of external elements ∑A, m²			233.81							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	107.38	(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		35.07	(36)
Total fabric heat loss	(33) + (36) =	142.45	(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)	29.42	29.10	28.77	27.13	26.81	25.17	25.17	24.84	25.83	26.81	27.46	28.11	(38)
Heat transfer coefficient, W/K (37)m + (38)m	171.87	171.55	171.22	169.58	169.26	167.62	167.62	167.30	168.28	169.26	169.91	170.57	
Average = ∑(39)1...12/12 =												169.50	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.56	1.56	1.56	1.54	1.54	1.52	1.52	1.52	1.53	1.54	1.54	1.55	
Average = ∑(40)1...12/12 =												1.54	(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	2.81	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	101.05	(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)	111.16	107.12	103.07	99.03	94.99	90.95	90.95	94.99	99.03	103.07	107.12	111.16	
∑(44)1...12 =												1212.63	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	164.84	144.17	148.77	129.70	124.45	107.39	99.52	114.20	115.56	134.68	147.01	159.64	
∑(45)1...12 =												1589.94	(45)
Distribution loss 0.15 x (45)m	24.73	21.63	22.32	19.46	18.67	16.11	14.93	17.13	17.33	20.20	22.05	23.95	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	210.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.40	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.76	(50)
Enter (50) or (54) in (55)	0.76	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	23.44	21.17	23.44	22.68	23.44	22.68	23.44	23.44	22.68	23.44	22.68	23.44	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	23.44	21.17	23.44	22.68	23.44	22.68	23.44	23.44	22.68	23.44	22.68	23.44	(57)

Primary circuit loss for each month from Table 3

	23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(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	211.54	186.35	195.47	174.90	171.15	152.59	146.22	160.90	160.75	181.37	192.20	206.34	(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	211.54	186.35	195.47	174.90	171.15	152.59	146.22	160.90	160.75	181.37	192.20	206.34	

∑(64)1...12 = 2139.78 (64)

Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]	92.17	81.68	86.83	79.28	78.74	71.86	70.45	75.33	74.58	82.14	85.03	90.44	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74	140.74	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	24.21	21.50	17.49	13.24	9.90	8.35	9.03	11.73	15.75	20.00	23.34	24.88	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	271.56	274.37	267.27	252.16	233.07	215.14	203.16	200.34	207.44	222.56	241.64	259.57	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07	37.07	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	-112.59	(71)
Water heating gains (Table 5)	123.88	121.55	116.70	110.11	105.83	99.81	94.69	101.25	103.58	110.40	118.10	121.56	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	487.87	485.65	469.68	443.73	417.02	391.52	375.09	381.54	394.99	421.18	451.31	474.24	(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	
East	0.77	x	49.41	x	19.64	x 0.9 x	0.30	x	1.00	=	201.75	(76)
West	0.77	x	41.72	x	19.64	x 0.9 x	0.30	x	1.00	=	170.35	(80)
South	0.77	x	16.44	x	46.75	x 0.9 x	0.30	x	1.00	=	159.79	(78)

Solar gains in watts ∑(74)m...(82)m	531.90	989.61	1532.13	2125.10	2535.26	2571.22	2457.36	2152.24	1742.45	1146.00	653.38	444.08	(83)
Total gains - internal and solar (73)m + (83)m	1019.77	1475.26	2001.81	2568.83	2952.29	2962.74	2832.45	2533.78	2137.44	1567.17	1104.68	918.31	(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	0.96	0.87	0.70	0.51	0.36	0.26	0.30	0.52	0.84	0.97	0.99	(86)

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

19.52	19.93	20.42	20.80	20.95	20.99	21.00	21.00	20.96	20.65	19.98	19.45	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.64	19.64	19.65	19.66	19.66	19.67	19.67	19.67	19.67	19.66	19.65	19.65	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.95	0.84	0.65	0.45	0.29	0.18	0.22	0.43	0.79	0.96	0.99	(89)

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

17.74	18.33	18.99	19.47	19.62	19.67	19.67	19.67	19.64	19.32	18.41	17.64	(90)

Living area fraction — Living area ÷ (4) = 0.33 (91)

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

18.33	18.85	19.46	19.90	20.06	20.10	20.10	20.10	20.07	19.75	18.92	18.23	(92)

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

18.18	18.70	19.31	19.75	19.91	19.95	19.95	19.95	19.92	19.60	18.77	18.08	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.94	0.83	0.65	0.46	0.30	0.20	0.23	0.45	0.79	0.95	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	999.33	1381.22	1668.79	1671.14	1352.33	891.59	561.56	593.39	956.67	1236.48	1054.81	905.30	(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]	2384.81	2367.57	2192.82	1840.42	1388.97	896.61	562.22	594.69	980.12	1523.89	1983.04	2367.40	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	1030.80	662.82	389.88	121.88	27.26	0.00	0.00	0.00	0.00	213.83	668.33	1087.80	

∑(98)1...5, 10...12 = 4202.61 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 38.21 (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 (%)		90.20	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	1142.79	734.84	432.24	135.12	30.22	0.00	0.00	0.00	0.00	237.06	740.94	1205.99

∑(211)1...5, 10...12 = 4659.21 (211)

Water heating

Efficiency of water heater	88.18	87.61	86.32	83.57	80.82	79.50	79.50	79.50	79.50	84.95	87.57	88.31	(217)
Water heating fuel, kWh/month	239.90	212.70	226.45	209.28	211.78	191.93	183.92	202.38	202.21	213.50	219.49	233.67	

∑(219a)1...12 = 2547.20 (219)

Annual totals

Space heating fuel - main system 1			4659.21	
Water heating fuel			2547.20	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	457.62			(230a)
central heating pump or water pump within warm air heating unit	30.00			(230c)
boiler flue fan	45.00			(230e)
Total electricity for the above, kWh/year			532.62	(231)
Electricity for lighting (Appendix L)			427.55	(232)
Total delivered energy for all uses		(211)...(221) + (231) + (232)...(237b) =	8166.58	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4659.21	x	3.48	x 0.01 =	162.14	(240)
Water heating	2547.20	x	3.48	x 0.01 =	88.64	(247)
Pumps and fans	532.62	x	13.19	x 0.01 =	70.25	(249)
Electricity for lighting	427.55	x	13.19	x 0.01 =	56.39	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	497.43	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.35	(257)
SAP value	81.20	
SAP rating (section 13)	81	(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	4659.21	x	0.22	=	1006.39	(261)
Water heating	2547.20	x	0.22	=	550.20	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1556.59	(265)
Pumps and fans	532.62	x	0.52	=	276.43	(267)
Electricity for lighting	427.55	x	0.52	=	221.90	(268)
Total CO_2, kg/year				(265)...(271) =	2054.91	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	18.68	(273)
EI value					82.23	
EI rating (section 14)					82	(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	4659.21	x	1.22	=	5684.24	(261)
Water heating	2547.20	x	1.22	=	3107.59	(264)
Space and water heating				(261) + (262) + (263) + (264) =	8791.83	(265)
Pumps and fans	532.62	x	3.07	=	1635.15	(267)
Electricity for lighting	427.55	x	3.07	=	1312.57	(268)
Primary energy kWh/year					11739.54	(272)

Dwelling primary energy rate kWh/m2/year	106.72	(273)

DER Worksheet
Design - Draft

HODKINSON

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	Miss Charlotte Booth	Assessor number	6376
Client	Warmhaze Ltd	Last modified	23/01/2015
Address	12 17-27 & 25 Ferdinand Street, Camden, London, NW1 8EX		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		60.42	(1a)	x	3.13	(2a)	=	189.11	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	60.42	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			189.11	(5)

2. Ventilation rate

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

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

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)
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) =	0.12	(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	0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(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	77.35	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(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			12.12	x	0.87	=	10.53			(27)
External wall			27.01	x	0.16	=	4.32			(29a)
Party wall			69.61	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			39.13							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	14.85	(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		5.87	(36)
Total fabric heat loss	(33) + (36) =	20.72	(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)	16.32	16.14	15.95	15.05	14.87	13.96	13.96	13.78	14.32	14.87	15.23	15.59	(38)
Heat transfer coefficient, W/K (37)m + (38)m	37.04	36.86	36.68	35.77	35.59	34.68	34.68	34.50	35.04	35.59	35.95	36.31	
Average = ∑(39)1...12/12 =												35.72	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.61	0.61	0.61	0.59	0.59	0.57	0.57	0.57	0.58	0.59	0.59	0.60	
Average = ∑(40)1...12/12 =												0.59	(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	1.99	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	81.55	(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)	89.70	86.44	83.18	79.91	76.65	73.39	73.39	76.65	79.91	83.18	86.44	89.70	
∑(44)1...12 =												978.54	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	133.02	116.34	120.05	104.67	100.43	86.66	80.31	92.15	93.25	108.68	118.63	128.82	
∑(45)1...12 =												1283.02	(45)
Distribution loss 0.15 x (45)m	19.95	17.45	18.01	15.70	15.06	13.00	12.05	13.82	13.99	16.30	17.79	19.32	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(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	45.71	39.79	42.39	39.41	39.06	36.19	37.40	39.06	39.41	42.39	42.63	45.71	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m	178.73	156.13	162.44	144.08	139.49	122.86	117.71	131.21	132.66	151.06	161.26	174.53	(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

178.73	156.13	162.44	144.08	139.49	122.86	117.71	131.21	132.66	151.06	161.26	174.53	

∑(64)1...12 = 1772.16 (64)

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

55.66	48.63	50.51	44.65	43.16	37.86	36.05	40.41	40.86	46.73	50.10	54.26	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67	99.67	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	16.60	14.74	11.99	9.08	6.79	5.73	6.19	8.05	10.80	13.71	16.00	17.06	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	174.00	175.81	171.26	161.57	149.35	137.85	130.18	128.37	132.92	142.61	154.84	166.33	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97	32.97	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-79.74	-79.74	-79.74	-79.74	-79.74	-79.74	-79.74	-79.74	-79.74	-79.74	-79.74	-79.74	(71)
Water heating gains (Table 5)	74.81	72.37	67.90	62.02	58.01	52.59	48.46	54.31	56.75	62.81	69.59	72.93	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	321.31	318.82	307.05	288.57	270.04	252.07	240.72	246.63	256.37	275.03	296.33	312.22	(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	
East	0.54	x	12.12	x	19.64	x 0.9 x	0.50	x	0.70	=	40.49	(76)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains in watts ∑(74)m...(82)m	40.49	79.21	130.44	190.25	233.15	238.67	227.23	195.18	151.71	93.99	50.49	33.30	(83)
Total gains - internal and solar (73)m + (83)m	361.81	398.03	437.49	478.82	503.20	490.75	467.95	441.81	408.08	369.02	346.81	345.52	(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)	1.00	0.99	0.96	0.85	0.65	0.45	0.33	0.36	0.59	0.90	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.56	20.66	20.81	20.95	21.00	21.00	21.00	21.00	21.00	20.93	20.73	20.54	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)	20.42	20.42	20.42	20.44	20.44	20.45	20.45	20.46	20.45	20.44	20.43	20.43	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.99	0.95	0.82	0.61	0.41	0.29	0.32	0.54	0.87	0.98	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	20.01	20.11	20.26	20.40	20.44	20.45	20.45	20.46	20.45	20.39	20.20	20.01	(90)

Living area fraction Living area ÷ (4) = 0.41 (91)

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

20.23	20.33	20.48	20.63	20.67	20.68	20.68	20.68	20.67	20.61	20.41	20.22	(92)

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

20.08	20.18	20.33	20.48	20.52	20.53	20.53	20.53	20.52	20.46	20.26	20.07	(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	0.82	0.62	0.42	0.29	0.32	0.55	0.87	0.98	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m													
	359.50	391.90	415.42	393.65	311.90	205.51	136.20	142.44	224.59	322.78	340.46	343.90	(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]													
	584.57	563.32	507.39	414.12	313.72	205.55	136.20	142.44	225.08	351.02	473.22	576.46	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
	167.45	115.20	68.43	14.74	1.35	0.00	0.00	0.00	0.00	21.01	95.58	173.02	

∑(98)1...5, 10...12 = 656.78 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) = 10.87 (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 (%)		90.00	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month													
	186.05	128.00	76.03	16.38	1.50	0.00	0.00	0.00	0.00	23.35	106.21	192.25	

∑(211)1...5, 10...12 = 729.76 (211)

Water heating

Efficiency of water heater													
	84.49	83.90	82.65	80.74	79.99	79.90	79.90	79.90	79.90	81.01	83.38	84.63	(217)
Water heating fuel, kWh/month													
	211.55	186.09	196.54	178.44	174.39	153.76	147.32	164.22	166.04	186.47	193.39	206.24	

∑(219a)1...12 = 2164.47 (219)

Annual totals

Space heating fuel - main system 1		729.76	
Water heating fuel		2164.47	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	253.79		(230a)
central heating pump or water pump within warm air heating unit	30.00		(230c)
boiler flue fan	45.00		(230e)
Total electricity for the above, kWh/year		328.79	(231)
Electricity for lighting (Appendix L)		293.14	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	3516.17	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	729.76	x	3.48	x 0.01 =	25.40	(240)
Water heating	2164.47	x	3.48	x 0.01 =	75.32	(247)
Pumps and fans	328.79	x	13.19	x 0.01 =	43.37	(249)
Electricity for lighting	293.14	x	13.19	x 0.01 =	38.67	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	302.75	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.21	(257)
SAP value	83.17	
SAP rating (section 13)	83	(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	729.76	x	0.22	=	157.63	(261)
Water heating	2164.47	x	0.22	=	467.53	(264)
Space and water heating			(261) + (262) + (263) + (264) =		625.15	(265)
Pumps and fans	328.79	x	0.52	=	170.64	(267)
Electricity for lighting	293.14	x	0.52	=	152.14	(268)
Total CO_2, kg/year				(265)...(271) =	947.94	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	15.69	(273)
EI value					87.95	
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	729.76	x	1.22	=	890.31	(261)
Water heating	2164.47	x	1.22	=	2640.65	(264)
Space and water heating			(261) + (262) + (263) + (264) =		3530.96	(265)
Pumps and fans	328.79	x	3.07	=	1009.39	(267)
Electricity for lighting	293.14	x	3.07	=	899.95	(268)
Primary energy kWh/year					5440.31	(272)
Dwelling primary energy rate kWh/m2/year					90.04	(273)

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	Miss Charlotte Booth	Assessor number	6376
Client	Warmhaze Ltd	Last modified	23/01/2015
Address	7 17-27 & 25 Ferdinand Street, Camden, London, NW1 8EX		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		66.22	(1a)	x	3.13	(2a)	=	207.27	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	66.22	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			207.27	(5)

2. Ventilation rate

				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		0	x 10 =	0	(7a)
Number of passive vents		0	x 10 =	0	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)
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) =	0.12	(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	0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(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	77.35	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(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			25.90	x	0.87	=	22.50			(27)
External wall			37.22	x	0.16	=	5.96			(29a)
Party wall			21.12	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			63.12							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	28.46	(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		9.47	(36)
Total fabric heat loss	(33) + (36) =	37.92	(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)	17.88	17.69	17.49	16.49	16.29	15.30	15.30	15.10	15.70	16.29	16.69	17.09	(38)
Heat transfer coefficient, W/K (37)m + (38)m	55.81	55.61	55.41	54.42	54.22	53.22	53.22	53.02	53.62	54.22	54.61	55.01	

Average = ∑(39)1...12/12 = 54.37 (39)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.84	0.84	0.84	0.82	0.82	0.80	0.80	0.80	0.81	0.82	0.82	0.83	

Average = ∑(40)1...12/12 = 0.82 (40)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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	2.15	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	85.29	(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)	93.81	90.40	86.99	83.58	80.17	76.76	76.76	80.17	83.58	86.99	90.40	93.81	

∑(44)1...12 = 1023.43 (44)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	139.12	121.68	125.56	109.47	105.04	90.64	83.99	96.38	97.53	113.66	124.07	134.73	

∑(45)1...12 = 1341.88 (45)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss 0.15 x (45)m	20.87	18.25	18.83	16.42	15.76	13.60	12.60	14.46	14.63	17.05	18.61	20.21	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(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	47.81	41.61	44.33	41.22	40.85	37.85	39.11	40.85	41.22	44.33	44.58	47.81	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m	186.93	163.29	169.89	150.69	145.89	128.49	123.10	137.23	138.75	157.99	168.65	182.54	(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

186.93	163.29	169.89	150.69	145.89	128.49	123.10	137.23	138.75	157.99	168.65	182.54

∑(64)1...12 = 1853.45 (64)

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

58.21	50.86	52.83	46.70	45.14	39.60	37.71	42.26	42.73	48.88	52.40	56.75	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	107.55	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	16.79	14.91	12.13	9.18	6.86	5.79	6.26	8.14	10.92	13.87	16.19	17.26	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	188.32	190.27	185.35	174.87	161.63	149.19	140.89	138.93	143.86	154.34	167.57	180.01	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	33.75	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-86.04	-86.04	-86.04	-86.04	-86.04	-86.04	-86.04	-86.04	-86.04	-86.04	-86.04	-86.04	(71)
Water heating gains (Table 5)	78.24	75.69	71.01	64.86	60.67	55.00	50.68	56.80	59.35	65.69	72.78	76.28	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	341.61	339.14	326.75	307.18	287.43	268.25	256.09	262.13	272.39	292.16	314.80	331.81	(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	
West	0.77	x	7.40	x	19.64	x 0.9 x	0.50	x	0.70	=	35.25	(80)
North	0.77	x	11.10	x	10.63	x 0.9 x	0.50	x	0.70	=	28.63	(74)
NorthEast	0.77	x	7.40	x	11.28	x 0.9 x	0.50	x	0.70	=	20.25	(75)

Solar gains in watts ∑(74)m...(82)m	84.13	164.89	280.80	436.93	568.10	597.93	562.39	459.80	334.36	197.33	104.75	69.39	(83)
Total gains - internal and solar (73)m + (83)m	425.74	504.03	607.55	744.11	855.53	866.18	818.48	721.93	606.75	489.49	419.55	401.20	(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)	1.00	0.99	0.96	0.81	0.58	0.39	0.29	0.34	0.60	0.92	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.24	20.40	20.66	20.92	20.99	21.00	21.00	21.00	20.99	20.83	20.48	20.21	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)	20.22	20.22	20.22	20.23	20.24	20.25	20.25	20.25	20.24	20.24	20.23	20.23	(88)
Utilisation factor for gains for rest of dwelling n2,m	1.00	0.99	0.94	0.78	0.54	0.35	0.24	0.28	0.54	0.90	0.99	1.00	(89)

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

19.52	19.69	19.94	20.17	20.23	20.25	20.25	20.25	20.24	20.11	19.78	19.50	(90)

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

19.77	19.94	20.19	20.44	20.50	20.51	20.51	20.52	20.50	20.36	20.02	19.75	(92)

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

19.62	19.79	20.04	20.29	20.35	20.36	20.36	20.37	20.35	20.21	19.87	19.60	(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	0.94	0.78	0.54	0.35	0.24	0.29	0.55	0.89	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	423.42	496.05	571.01	578.68	464.98	306.56	200.30	210.22	332.57	438.09	413.64	399.64	(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]	855.04	827.91	750.50	619.53	468.89	306.74	200.31	210.25	335.39	521.21	697.64	847.23	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	321.12	223.01	133.54	29.41	2.91	0.00	0.00	0.00	0.00	61.84	204.48	333.00	

∑(98)1...5, 10...12 = 1309.31 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 19.77 (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 (%)		90.00	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	356.80	247.78	148.37	32.68	3.24	0.00	0.00	0.00	0.00	68.71	227.20	370.00

∑(211)1...5, 10...12 = 1454.79 (211)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Efficiency of water heater	86.00	85.43	84.05	81.39	80.08	79.90	79.90	79.90	79.90	82.50	85.14	86.14	(217)
Water heating fuel, kWh/month	217.36	191.13	202.13	185.14	182.19	160.82	154.07	171.76	173.65	191.50	198.10	211.90	

∑(219a)1...12 = 2239.74 (219)

Annual totals

Space heating fuel - main system 1		1454.79	
Water heating fuel		2239.74	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	278.15		(230a)
central heating pump or water pump within warm air heating unit	30.00		(230c)
boiler flue fan	45.00		(230e)
Total electricity for the above, kWh/year		353.15	(231)

Electricity for lighting (Appendix L)		296.50	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	4344.18	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1454.79	x	3.48	x 0.01 =	50.63	(240)
Water heating	2239.74	x	3.48	x 0.01 =	77.94	(247)
Pumps and fans	353.15	x	13.19	x 0.01 =	46.58	(249)
Electricity for lighting	296.50	x	13.19	x 0.01 =	39.11	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	334.26	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.26	(257)
SAP value	82.39	
SAP rating (section 13)	82	(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	1454.79	x	0.22	=	314.23	(261)
Water heating	2239.74	x	0.22	=	483.78	(264)
Space and water heating				(261) + (262) + (263) + (264) =	798.02	(265)
Pumps and fans	353.15	x	0.52	=	183.29	(267)
Electricity for lighting	296.50	x	0.52	=	153.88	(268)
Total CO_2, kg/year				(265)...(271) =	1135.19	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	17.14	(273)
EI value					86.32	
EI rating (section 14)					86	(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	1454.79	x	1.22	=	1774.85	(261)
Water heating	2239.74	x	1.22	=	2732.48	(264)
Space and water heating				(261) + (262) + (263) + (264) =	4507.33	(265)
Pumps and fans	353.15	x	3.07	=	1084.18	(267)
Electricity for lighting	296.50	x	3.07	=	910.24	(268)
Primary energy kWh/year					6501.75	(272)
Dwelling primary energy rate kWh/m2/year					98.18	(273)

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	Miss Charlotte Booth	Assessor number	6376
Client	Warmhaze Ltd	Last modified	23/01/2015
Address	5 17-27 & 25 Ferdinand Street, Camden, London, NW1 8EX		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		52.05	(1a)	x	3.13	(2a)	=	162.92	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	52.05	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	162.92	(5)

2. Ventilation rate

				m³ per hour	
Number of chimneys		0	x 40 =	0	(6a)
Number of open flues		0	x 20 =	0	(6b)
Number of intermittent fans		0	x 10 =	0	(7a)
Number of passive vents		0	x 10 =	0	(7b)
Number of flueless gas fires		0	x 40 =	0	(7c)
				Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)
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) =	0.12	(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	0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(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	77.35	(23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(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			19.62	x	0.87	=	17.04			(27)
External wall			44.67	x	0.16	=	7.15			(29a)
Party wall			60.57	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			64.29							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	24.19	(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		9.64	(36)
Total fabric heat loss	(33) + (36) =	33.84	(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)	14.06	13.90	13.74	12.96	12.81	12.03	12.03	11.87	12.34	12.81	13.12	13.43	(38)
Heat transfer coefficient, W/K (37)m + (38)m	47.89	47.74	47.58	46.80	46.64	45.86	45.86	45.70	46.17	46.64	46.95	47.27	
Average = ∑(39)1...12/12 =												46.76	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.92	0.92	0.91	0.90	0.90	0.88	0.88	0.88	0.89	0.90	0.90	0.91	
Average = ∑(40)1...12/12 =												0.90	(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	1.75	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	75.78	(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)	83.35	80.32	77.29	74.26	71.23	68.20	68.20	71.23	74.26	77.29	80.32	83.35	
∑(44)1...12 =												909.31	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	123.61	108.11	111.56	97.26	93.32	80.53	74.62	85.63	86.66	100.99	110.24	119.71	
∑(45)1...12 =												1192.24	(45)
Distribution loss 0.15 x (45)m	18.54	16.22	16.73	14.59	14.00	12.08	11.19	12.84	13.00	15.15	16.54	17.96	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(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	42.48	36.97	39.39	36.62	36.30	33.63	34.75	36.30	36.62	39.39	39.61	42.48	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m	166.09	145.08	150.95	133.88	129.62	114.16	109.38	121.93	123.28	140.37	149.85	162.19	(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

166.09	145.08	150.95	133.88	129.62	114.16	109.38	121.93	123.28	140.37	149.85	162.19	

∑(64)1...12 = 1646.77 (64)

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

51.72	45.19	46.94	41.49	40.10	35.18	33.50	37.55	37.97	43.43	46.56	50.42	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	87.53	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	13.60	12.08	9.82	7.44	5.56	4.69	5.07	6.59	8.85	11.23	13.11	13.98	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	152.56	154.14	150.15	141.66	130.94	120.86	114.13	112.55	116.54	125.03	135.75	145.82	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	31.75	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	-70.02	(71)
Water heating gains (Table 5)	69.52	67.25	63.09	57.63	53.90	48.87	45.03	50.47	52.73	58.37	64.66	67.77	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	287.93	285.72	275.32	258.98	242.66	226.68	216.49	221.86	230.38	246.89	265.78	279.83	(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	
West	0.77	x	19.62	x	19.64	x 0.9 x	0.50	x	0.70	=	93.46	(80)

Solar gains in watts ∑(74)m...(82)m	93.46	182.84	301.11	439.15	538.19	550.93	524.51	450.55	350.20	216.95	116.54	76.86	(83)
Total gains - internal and solar (73)m + (83)m	381.39	468.56	576.43	698.13	780.85	777.61	741.00	672.41	580.57	463.84	382.32	356.69	(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	0.92	0.76	0.55	0.38	0.27	0.31	0.54	0.88	0.98	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.21	20.42	20.70	20.93	20.99	21.00	21.00	21.00	20.99	20.85	20.48	20.17	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)	20.15	20.15	20.16	20.17	20.17	20.18	20.18	20.19	20.18	20.17	20.17	20.16	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.97	0.90	0.72	0.50	0.33	0.22	0.26	0.48	0.84	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	19.43	19.64	19.91	20.12	20.17	20.18	20.18	20.19	20.18	20.07	19.71	19.41	(90)

Living area fraction Living area ÷ (4) = 0.49 (91)

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

19.81	20.02	20.30	20.51	20.57	20.58	20.58	20.58	20.57	20.45	20.09	19.78	(92)

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

19.66	19.87	20.15	20.36	20.42	20.43	20.43	20.43	20.42	20.30	19.94	19.63	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.97	0.90	0.73	0.52	0.34	0.24	0.27	0.50	0.85	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	377.87	455.32	521.19	507.45	403.08	267.19	175.70	184.28	289.97	394.04	373.40	354.35	(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]	735.67	714.57	649.37	536.45	406.60	267.42	175.72	184.31	292.01	452.44	602.71	729.30	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	266.20	174.22	95.37	20.88	2.62	0.00	0.00	0.00	0.00	43.44	165.10	278.96	

	∑(98)1...5, 10...12 =	1046.79	(98)
Space heating requirement kWh/m²/year	(98) ÷ (4)	20.11	(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 (%)		90.00	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	295.78	193.58	105.96	23.20	2.91	0.00	0.00	0.00	0.00	48.27	183.45	309.96

∑(211)1...5, 10...12 = 1163.10 (211)

Water heating

Efficiency of water heater	85.83	85.11	83.53	81.13	80.08	79.90	79.90	79.90	79.90	82.08	84.89	86.00	(217)
Water heating fuel, kWh/month	193.50	170.46	180.71	165.03	161.87	142.88	136.89	152.60	154.29	171.03	176.51	188.58	

∑(219a)1...12 = 1994.35 (219)

Annual totals

Space heating fuel - main system 1			1163.10	
Water heating fuel			1994.35	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside	218.63			(230a)
central heating pump or water pump within warm air heating unit	30.00			(230c)
boiler flue fan	45.00			(230e)
Total electricity for the above, kWh/year			293.63	(231)
Electricity for lighting (Appendix L)			240.19	(232)
Total delivered energy for all uses		(211)...(221) + (231) + (232)...(237b) =	3691.28	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1163.10	x	3.48	x 0.01 =	40.48	(240)
Water heating	1994.35	x	3.48	x 0.01 =	69.40	(247)
Pumps and fans	293.63	x	13.19	x 0.01 =	38.73	(249)
Electricity for lighting	240.19	x	13.19	x 0.01 =	31.68	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	300.29	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.30	(257)
SAP value	81.87	
SAP rating (section 13)	82	(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	1163.10	x	0.22	=	251.23	(261)
Water heating	1994.35	x	0.22	=	430.78	(264)
Space and water heating				(261) + (262) + (263) + (264) =	682.01	(265)
Pumps and fans	293.63	x	0.52	=	152.40	(267)
Electricity for lighting	240.19	x	0.52	=	124.66	(268)
Total CO_2, kg/year				(265)...(271) =	959.06	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	18.43	(273)
EI value					86.76	
EI rating (section 14)					87	(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	1163.10	x	1.22	=	1418.98	(261)
Water heating	1994.35	x	1.22	=	2433.11	(264)
Space and water heating				(261) + (262) + (263) + (264) =	3852.09	(265)
Pumps and fans	293.63	x	3.07	=	901.46	(267)
Electricity for lighting	240.19	x	3.07	=	737.38	(268)
Primary energy kWh/year					5490.93	(272)
Dwelling primary energy rate kWh/m2/year					105.49	(273)

DER Worksheet
Design - Draft

HODKINSON

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	Miss Charlotte Booth	Assessor number	6376
Client	Warmhaze Ltd	Last modified	23/01/2015
Address	3 17-27 & 25 Ferdinand Street, Camden, London, NW1 8EX		

1. Overall dwelling dimensions

		Area (m^2)			Average storey height (m)			Volume (m^3)	
Lowest occupied		69.34	(1a)	x	3.49	(2a)	=	242.00	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	69.34	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	242.00	(5)

2. Ventilation rate

			m³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)
			Air changes per hour	
Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) =	0	÷ (5) =	0.00	(8)

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area		3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.15	(18)
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) =	0.12	(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	0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14	(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	77.35	(23c)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(24a)
Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.26	0.26	0.26	0.24	0.24	0.22	0.22	0.22	0.23	0.24	0.24	0.25	(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			26.71	x	0.87	=	23.20			(27)
Ground floor			69.34	x	0.10	=	6.93			(28a)
External wall			45.39	x	0.16	=	7.26			(29a)
Party wall			70.22	x	0.00	=	0.00			(32)
Total area of external elements ∑A, m²			141.44							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	37.40	(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		21.22	(36)
Total fabric heat loss	(33) + (36) =	58.62	(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)	20.88	20.65	20.42	19.26	19.02	17.86	17.86	17.63	18.33	19.02	19.49	19.95	(38)
Heat transfer coefficient, W/K (37)m + (38)m	79.50	79.26	79.03	77.87	77.64	76.48	76.48	76.25	76.94	77.64	78.10	78.57	
Average = ∑(39)1...12/12 =												77.81	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.15	1.14	1.14	1.12	1.12	1.10	1.10	1.10	1.11	1.12	1.13	1.13	
Average = ∑(40)1...12/12 =												1.12	(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	2.23	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	87.16	(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)	95.88	92.39	88.91	85.42	81.93	78.45	78.45	81.93	85.42	88.91	92.39	95.88	
∑(44)1...12 =												1045.95	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	142.19	124.36	128.32	111.88	107.35	92.63	85.84	98.50	99.68	116.16	126.80	137.70	
∑(45)1...12 =												1371.40	(45)
Distribution loss 0.15 x (45)m	21.33	18.65	19.25	16.78	16.10	13.89	12.88	14.78	14.95	17.42	19.02	20.65	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(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	48.86	42.53	45.31	42.12	41.75	38.69	39.98	41.75	42.12	45.31	45.56	48.86	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m	191.04	166.88	173.63	154.00	149.10	131.32	125.81	140.25	141.80	161.47	172.37	186.56	(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

191.04	166.88	173.63	154.00	149.10	131.32	125.81	140.25	141.80	161.47	172.37	186.56	

∑(64)1...12 = 1894.23 (64)

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

59.49	51.98	53.99	47.73	46.13	40.47	38.54	43.19	43.67	49.95	53.55	58.00	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	111.50	111.50	111.50	111.50	111.50	111.50	111.50	111.50	111.50	111.50	111.50	111.50	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	17.45	15.50	12.61	9.54	7.13	6.02	6.51	8.46	11.35	14.42	16.83	17.94	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	195.75	197.78	192.66	181.77	168.01	155.08	146.45	144.41	149.53	160.43	174.19	187.11	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15	34.15	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	-89.20	(71)
Water heating gains (Table 5)	79.96	77.35	72.57	66.29	62.00	56.21	51.79	58.05	60.66	67.14	74.38	77.96	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	352.61	350.08	337.29	317.05	296.60	276.77	264.20	270.37	280.99	301.43	324.84	342.46	(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	
West	0.54	x	26.71	x	19.64	x 0.9 x	0.50	x	0.70	=	89.23	(80)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Solar gains in watts ∑(74)m...(82)m	89.23	174.56	287.47	419.26	513.82	525.99	500.76	430.15	334.34	207.13	111.26	73.38	(83)
Total gains - internal and solar (73)m + (83)m	441.85	524.64	624.77	736.31	810.42	802.75	764.96	700.52	615.34	508.56	436.10	415.84	(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)	1.00	0.99	0.98	0.92	0.79	0.59	0.44	0.49	0.77	0.96	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.80	19.98	20.27	20.64	20.88	20.98	21.00	20.99	20.92	20.57	20.11	19.77	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C)	19.96	19.97	19.97	19.98	19.98	20.00	20.00	20.00	19.99	19.98	19.98	19.97	(88)
Utilisation factor for gains for rest of dwelling n2,m	1.00	0.99	0.97	0.90	0.73	0.51	0.34	0.39	0.69	0.95	0.99	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	18.87	19.05	19.35	19.70	19.91	19.99	20.00	20.00	19.95	19.65	19.20	18.85	(90)

Living area fraction — Living area ÷ (4) = 0.37 (91)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
19.21	19.39	19.69	20.05	20.27	20.35	20.36	20.36	20.31	19.99	19.54	19.19	(92)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
19.06	19.24	19.54	19.90	20.12	20.20	20.21	20.21	20.16	19.84	19.39	19.04	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	1.00	0.99	0.97	0.89	0.74	0.52	0.36	0.41	0.70	0.94	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	439.83	518.90	604.24	657.43	596.42	420.74	275.57	289.13	433.44	479.73	431.84	414.42	(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]	1173.58	1136.77	1030.44	856.49	653.66	428.55	276.46	290.88	466.26	717.09	959.55	1166.02	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	545.91	415.21	317.10	143.33	42.59	0.00	0.00	0.00	0.00	176.60	379.95	559.19	

∑(98)1...5, 10...12 = 2579.87 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 37.21 (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 (%)		90.00	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	606.57	461.35	352.33	159.25	47.32	0.00	0.00	0.00	0.00	196.22	422.17	621.32

∑(211)1...5, 10...12 = 2866.52 (211)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Efficiency of water heater	87.14	86.85	86.15	84.47	81.94	79.90	79.90	79.90	79.90	84.88	86.58	87.24	(217)
Water heating fuel, kWh/month	219.23	192.14	201.55	182.32	181.96	164.35	157.46	175.54	177.47	190.24	199.07	213.84	

∑(219a)1...12 = 2255.17 (219)

Annual totals

Space heating fuel - main system 1		2866.52	
Water heating fuel		2255.17	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	324.76		(230a)
central heating pump or water pump within warm air heating unit	30.00		(230c)
boiler flue fan	45.00		(230e)
Total electricity for the above, kWh/year		399.76	(231)
Electricity for lighting (Appendix L)		308.20	(232)

Total delivered energy for all uses			(211)...(221) + (231) + (232)...(237b) =	5829.65	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2866.52	x	3.48	x 0.01 =	99.75	(240)
Water heating	2255.17	x	3.48	x 0.01 =	78.48	(247)
Pumps and fans	399.76	x	13.19	x 0.01 =	52.73	(249)
Electricity for lighting	308.20	x	13.19	x 0.01 =	40.65	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	391.61	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.44	(257)
SAP value	79.93	
SAP rating (section 13)	80	(258)
SAP band	C	

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	2866.52	x	0.22	=	619.17	(261)
Water heating	2255.17	x	0.22	=	487.12	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1106.29	(265)
Pumps and fans	399.76	x	0.52	=	207.48	(267)
Electricity for lighting	308.20	x	0.52	=	159.95	(268)
Total CO_2, kg/year				(265)...(271) =	1473.72	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	21.25	(273)
EI value					82.73	
EI rating (section 14)					83	(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	2866.52	x	1.22	=	3497.15	(261)
Water heating	2255.17	x	1.22	=	2751.31	(264)
Space and water heating				(261) + (262) + (263) + (264) =	6248.47	(265)
Pumps and fans	399.76	x	3.07	=	1227.26	(267)
Electricity for lighting	308.20	x	3.07	=	946.17	(268)
Primary energy kWh/year					8421.90	(272)
Dwelling primary energy rate kWh/m2/year					121.46	(273)

APPENDIX D: FEASIBILITY TABLE OF LOW CARBON & RENEWABLE ENERGY TECHNOLOGIES

Feasibility Study Table								
Technology	**Payback**	**Land Use Issues**	**Local Planning Requirements**	**Noise**	**Carbon Payback**	**Available Grants**	**Feasible?**	**Reason not Feasible or Selected**
Combined Heat & Power (CHP)	Medium	Air quality in residential area	None	In Plant Room	Yes	Tax Relief - ECA	No	Development too small. Insufficient space for plant room.
Biomass	None	Air quality in residential area	Encouraged for large scale developments	In Plant Room	Yes	Bio-energy Capital Grants Scheme	No	Development too small. Insufficient space for plant room.
Solar Thermal	High	Sufficient roof space required	Encouraged	None	~2 years	None	No	PV more appropriate
Solar Photovoltaic (PV)	**High**	**Sufficient roof space required**	**Encouraged**	**None**	**2-5 years**	**None**	**Yes**	**Selected if roof space is prioritised over green roofs.**
Ground Source Heat Pumps (GSHPs)	High	Requires large area for coils or borehole	Encouraged	None	Low	None	No	PV more appropriate
Air Source Heat Pumps (ASHPs)	Very High	Visual intrusion of external units	None	Low	Low	None	No	PV more appropriate
Wind Power	Low	Urban Area - low and turbulent wind; Visual impact	Encouraged for large scale developments	Yes	~1 year	None	No	Monitoring needed to assess wind speeds. Expensive
Hydro Power	Medium	Requires suitable water resource; Visual impact	None	Low	~1 year	None	No	-