10-22 CANFIELD PLACE

ENERGY STATEMENT

FEBRUARY 2017

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Imperial Resources SA

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1 EXECUTIVE SUMMARY

WSP | Parsons Brinkerhoff were commissioned by Imperial Resources S.A. to provide an Energy Strategy to support the proposed Canfield Place redevelopment in Camden. This Energy Strategy will be submitted as part of a suite of documents making the planning application pack.

Canfield Place is a new residential mews development located between Finchley Road Tube Station to the north and the Chiltern Railway tracks to the south. It involves demolition of 16 single storey garages and redevelopment of the site to provide 8 mews type residential dwellings (C3) comprising 3 x two storey properties and 5 x three storey properties with associated roof terraces.

1.1 ENERGY AND CARBON TARGETS

Multiple layers of energy and carbon requirements apply to the development at a national, regional, and local level; each of which requiring different targets to be met. This strategy aims to address how these requirements can be met.

The relevant targets can be summarised as follows:

- All development must meet the prevailing Building Regulations requirements. The development will be brought forward under Part L 2013 and this has been used as the basis of this energy strategy.
- In line with the London Plan, Camden Borough Council requires new developments to achieve a 35% reduction in carbon emissions compared to the minimum requirements of Part L 2013.
- There is no Code for Sustainable Homes requirement, instead the project is aspiring to achieve 3 stars under the Building Research Establishments Home Quality Mark.
- London Borough of Camden (LBC) requires that developments target a 20% reduction in carbon emissions through the use of low and zero carbon technologies.

1.2 ENERGY STRATEGY

In accordance with best practice, this energy statement follows the principles of the energy hierarchy: Be Lean, Be Clean, Be Green.

The proposals for the scheme have been developed in accordance with the desire to provide homes of good environmental performance and will incorporate the following features:

- Building fabric which will significantly exceed the minimum fabric requirements of Part L1A (2013) of the Building Regulations
- 100% low energy lighting
- Mechanical ventilation with heat recovery (MVHR) systems for ventilation
- Air source heat pump to provide heating and hot water in line with the requirements of Core Strategy Policy CS13

1.3 RESULTS

Accredited Design SAP 2012 software was used to determine the regulated and non-regulated carbon emissions and fabric efficiency standards for a representative sample of 4 of the homes.

The results were then extrapolated across the whole development to project the total baseline carbon emissions, the carbon emissions after the application of energy efficiency measures, and the carbon emissions after the application of low and zero carbon technologies.

The results, summarised in Table 1-1, show compliance with Camden and the GLA's target of 35% carbon emissions reduction over Part L (2013) of the Building Regulations.

Table 1-1 Carbon Emission Reductions

	REGULATED EMISSIONS (TCO_2)	UNREGULATED EMISSIONS (T CO_2)	% REDUCTION IN REGULATED EMISSIONS
Part L Compliant Development	13.40	6.57	0.00%
After energy demand reduction	10.11	6.57	24.57%
After energy efficient supply	10.11	6.57	24.57%
After renewable energy	8.56	6.57	**35.44%**

2 PROJECT BACKGROUND

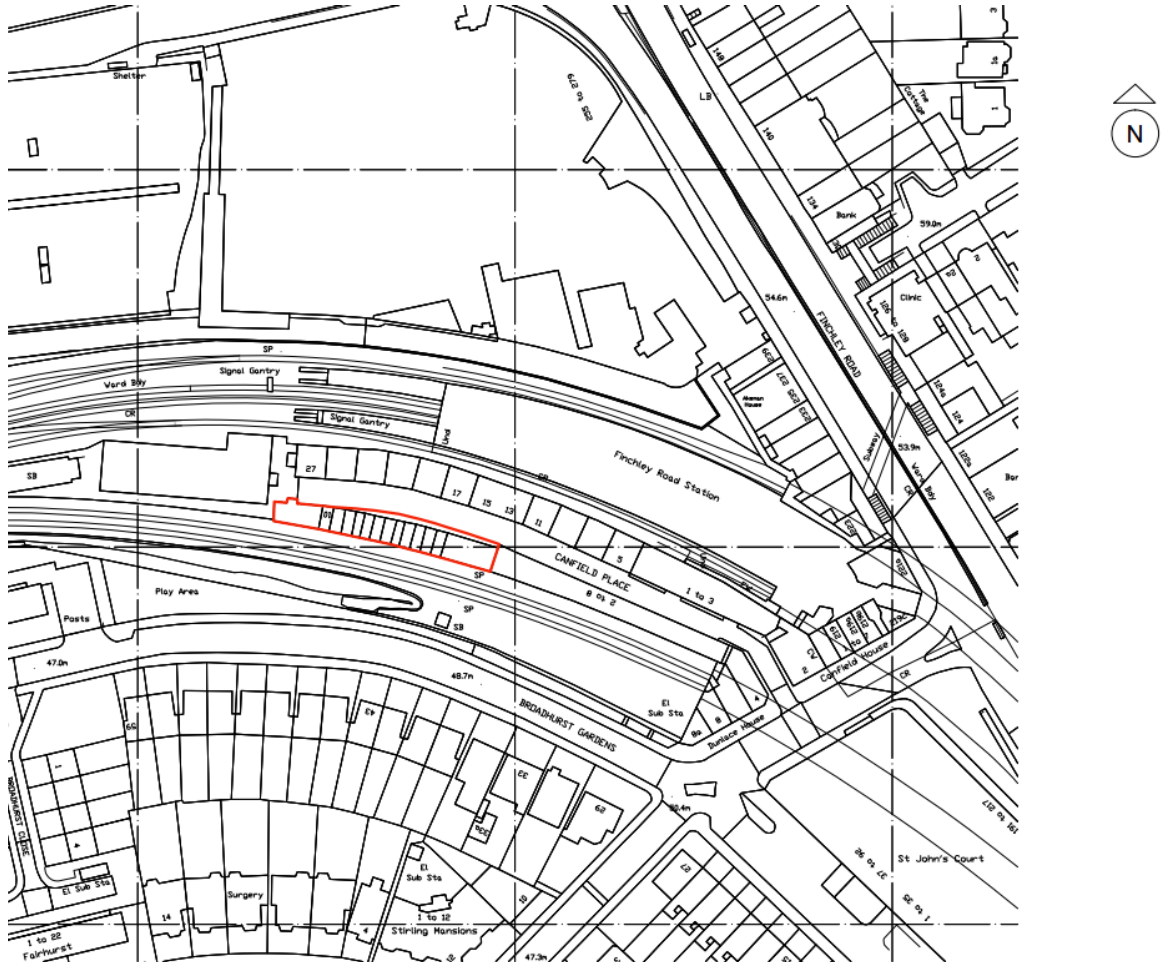
2.1 DEVELOPMENT DESCRIPTION

Canfield Place, London NW6, is a mews development located between the Finchley Road tube station to the north and national rail tracks to south in the London Borough of Camden. The site is presently occupied by 16 single storeys lock-up garages with access provided from Canfield Gardens to the east.

The proposal would demolish the garages and replace them with a new development of 8 independent mews houses. There are 4 house types with 3 houses being two storeys high and 5 houses being three storeys high. All units are predominantly north facing.

For further details see the *Design and Access Statement*.

Figure 2-1 Site Location Map for the Proposed Development (site boundary within red line)



3 POLICY CONTEXT

LBC's approach to sustainable development is underpinned by policies from the London Plan, Camden's Core Strategy and LBC's draft Local Plan and Supplementary Planning Guidance documents.

3.1 THE LONDON PLAN

The Mayor of London published the London Plan in July 2011 with amendments in 2013, 2015, and 2016. Key policies underpinning London's approach to sustainable development include:

- Policy 5.1 – Climate Change Mitigation
- Policy 5.2 – Minimising Carbon Dioxide Emissions
- Policy 5.3 – Sustainable Design and Construction
- Policy 5.5 – Decentralised Energy Networks
- Policy 5.6 – Decentralised Energy in Development Proposals
- Policy 5.7 – Renewable Energy
- Policy 5.9 – Overheating and cooling

The Mayor's London Plan sets out policy in the London context and identifies a number of objectives to improve the City as a place to work and live. Policy 5.2 sets out the requirements to minimise CO_2 emissions through the application of the energy hierarchy which is split into three distinct stages:

1. **Be lean**: use less energy
2. **Be clean**: supply energy efficiently
3. **Be green**: use renewable energy

London Plan policy requires dwellings to achieve a 35% carbon emissions reduction over Part L (2013) of the Building Regulations.

The London Plan requires an assessment of energy demand that demonstrates the steps taken to apply the Mayor's energy hierarchy. The London Plan includes planning policies both for reducing energy consumption within buildings and the use of renewable energy. These policies cover the role of the boroughs in supporting the Mayor's energy strategy and the requirements of planning applications.

POLICY 5.2

From October 2016 major residential development are required to achieve zero carbon, with at least 35% reduction achieved through on-site measures. The remaining regulated carbon emissions (up to 100%) are to be offset through a payment in lieu contribution.

Whilst usually a major development is deemed to be 10 units or above, Camden have confirmed their intent to charge £90 per tonne of Carbon offset for Canfield Place, which equates to £2,700 per tonne of CO_2 spread over a 30 year period, however the policy's application to this development is to be confirmed.

3.2 LBC'S CORE STRATEGY, DRAFT LOCAL PLAN AND SUSTAINABILITY SPG

The LBC Core Strategy was adopted in November 2010 and sets out key elements of Camden's vision for the borough and is a central part of the Local Development Framework which includes a group of documents setting out planning strategy and policies. The Core Strategy plays a key part in shaping the kind of place Camden will be in the future, balancing the needs of residents, businesses and future generations between 2010 and 2025.

On 24th June 2016 the Council submitted the Camden Local Plan and supporting documents to the Secretary of State for Communities and Local Government for independent examination. When finalised the Local Plan will replace Camden's current Core Strategy and development Policies documents as the basis for planning decisions.

The Camden Planning Guidance 3 (CPG3) Sustainability document provides support for policies in the LDF and covers a range of topics such as how to achieve carbon emission reductions, and reaffirms the GLA's commitment to achieve a 35% carbon emission reduction against Part L 2013. This document is an additional 'material' consideration in planning decisions and outlines Camden's commitment to reducing carbon emissions in the borough.

3.3 BUILDING REGULATIONS (PART L)

All new buildings constructed in the UK must meet the minimum requirements of the UK Building Regulations. Specifically with regard to energy and carbon compliance, all buildings must meet the building regulations Part L 'Target Emission Rate' (TER) requirements for the revision which is current at the time of construction works. The requirements of Part L 2013 will apply to Canfield Place. This includes the requirement for the dwellings to meet the new Target Fabric Energy Efficiency standards (TFEEs) introduced under Part L1A 2013.

4 BASELINE CO_2 EMISSIONS

The first stage of the energy assessment is to establish the baseline site energy demand and CO_2 emissions based on accredited SAP software.

NHER SAP software was used to establish the baseline regulated and unregulated carbon emissions for the development per annum.

Representative modelling has be undertaken on 4 dwellings, the results were then extrapolated to calculate the baseline carbon emissions and energy demand for the dwellings across the whole development.

Table 4-1The table below summarises these results.

Table 4-1 Baseline Regulated & Unregulated Carbon Emissions for the Proposed Development

	REGULATED EMISSIONS (TCO_2)	UNREGULATED EMISSIONS (TCO_2)
Building Regulations Part L 2013 Compliant Development	13.40	6.57

5 BE LEAN: REDUCE ENERGY DEMAND

Once a representative baseline has been projected, the next step to achieving Building Regulations compliance and the targets outlined previously is to reduce energy demand. The measures associated with reducing demand can be termed as 'Energy Efficiency Measures'.

The Proposed Development intends to incorporate relevant energy conservation measures; the benefits of which are discussed below. In summary the following will be included:

- Improved air tightness
- High performance building fabric
- High performance glazing
- 100% low energy lighting
- Whole house mechanical ventilation with heat recovery

5.1 BUILDING FABRIC

The building will be clad with in prefabricated brass panels fixed to traditional masonry or reinforced concrete walls. Alternatively prefabricated lightweight building units like Structural Insulated Panels will be used and also clad in brass.

At this stage it is anticipated that an overall U-value for the external walls will be 0.16W/m²K or better. For the purposes of this assessment the 1.6W/m²K value has been used, though solutions will be sought to reduce the U-value further where possible in order to realise further carbon reductions.

Glazing to the dwellings have been assumed to achieve a G-value of around 0.72. This is considered to provide an appropriate year round balance between maximising daylighting and beneficial wintertime solar gain, and minimising summertime solar gains to reduce the overheating risk.

The current proposals for the building fabric performance for Canfield Place are summarised in Table 5-1.

5.2 BUILDING SERVICES

Table 5-2 outlines the general approach to venting, lighting, and heating the Proposed Development.

Table 5-1 Fabric Performance Targets

ELEMENT	FABRIC PERFORMANCE TARGET
External Walls overall U-value (W/m²K)	0.16
Party wall U-value (W/m²K)	0.00
Ground floor U-value (W/m²K)	0.11
Roof U-value (W/m²K)	0.11
Windows U-value (W/m²K)	1.2
Air permeability (m³/hr.m² @ 50 Pa)	3.00

Table 5-2 General Heating, Ventilation and Lighting Specification

ELEMENT	GENERAL SPECIFICATION
Ventilation	Whole house mechanical ventilation with heat recovery (MVHR) units expected to achieve a specific fan power of 0.61W/l/s with a heat recovery efficiency of 88% or more.
Internal lighting	100% low energy.
Primary heat source	Gas fired boiler
Heating controls	Programmer, TRVs, and bypass.
Heat emitters	Underfloor heating (=<35⁰C)

5.3 CARBON EMISSION REDUCTION

Based upon the energy efficiency measures outlined, the following total carbon emissions are calculated in Table 5-33. These carbon emissions for the development are shown to be lower than the minimum requirements of the Building Regulations.

This is achieved via the use of the energy efficiency measures proposed (including a highly efficient building fabric, 100% low energy lighting and whole house mechanical ventilation and heat recovery systems) which far exceed the minimum requirements of the Regulations.

Also, appropriate glazing percentages were used on the facade so that a good balance between favouring daylight levels and beneficial heat gains in winter and avoiding excessive heat gains in summer could be achieved.

Table 5-3 Be Lean: Carbon Emissions after the Application of Energy Efficiency Measures

	REGULATED EMISSIONS (TCO_2)	UNREGULATED EMISSIONS (TCO_2)	REDUCTION IN REGULATED CARBON EMISSIONS
Building Regulations Part L 2013 Compliant Development	13.40	6.57	0.00%
After energy demand reduction	10.11	6.57	24.57%

5.4 PART L 2013 FABRIC ENERGY EFFICIENCY (FEE)

Accredited Design SAP2012 software was used to determine the FEE standards for the same sample of 4 typical dwellings. The results were then extrapolated across the whole development.

Results for the extrapolated target fabric energy efficiency (TFEE) and for the design building FEE are as follows:

Table 5-3 Fabric Energy by House

HOUSE	TARGET FEE (KWH M^2 YR)	DESIGN FEE (KWH M^2 YR)	IMPROVEMENT
HS-A2	43.80	32.30	26.30%
HS-B2	45.10	34.00	24.60%
HS-C1	43.50	31.60	27.40%
HS-D	50.20	38.30	23.70%

6 BE CLEAN: SUPPLY ENERGY EFFICIENTLY

After consumption has been reduced through the application of energy efficiency measures, the next step is to consider how low carbon technologies can provide further reduction in carbon dioxide emissions.

The following low carbon technologies have been investigated for the Proposed Development.

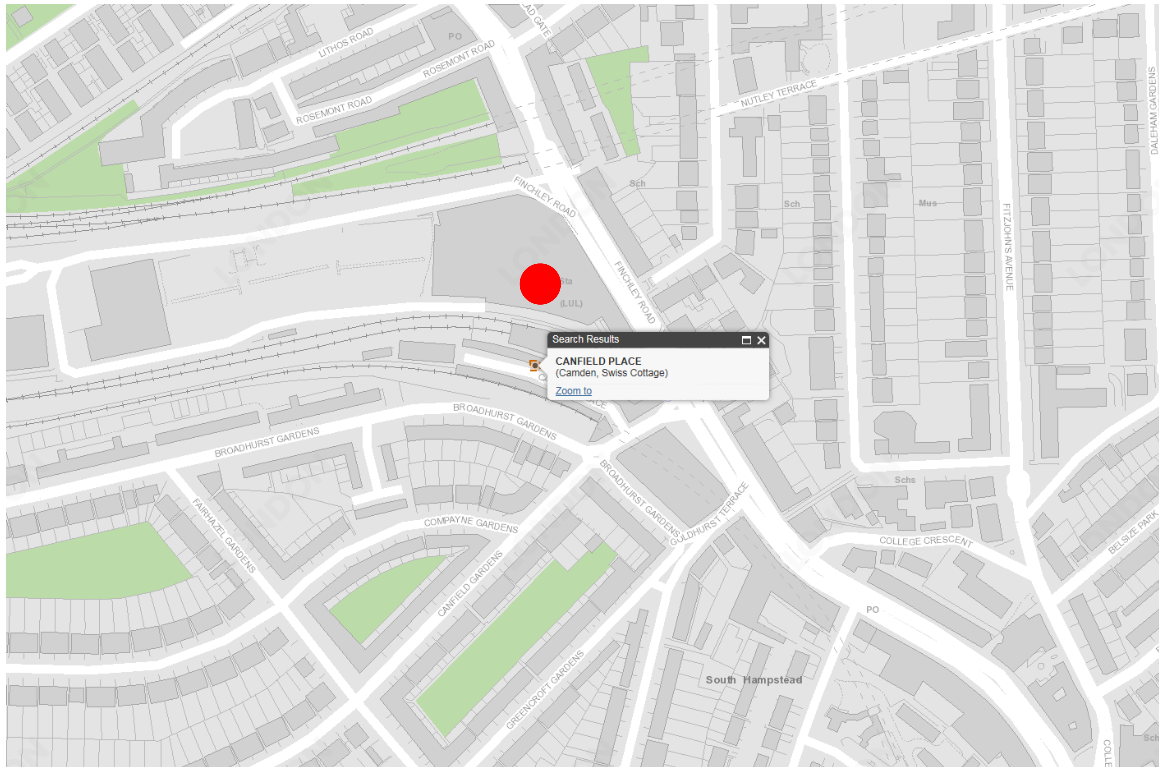
- District heating network
- Combined heat and power (CHP)

6.1 DISTRICT HEATING NETWORK

The London Heat Map identifies existing and potential opportunities for decentralised energy projects in London. It builds on the 2005 London Community Heating Development Study. An excerpt from the London Heat Map (Figure 6-1) controlled to show the location of any existing and proposed district heating systems within the vicinity of the development. The location of the Canfield Place development is highlighted in red.

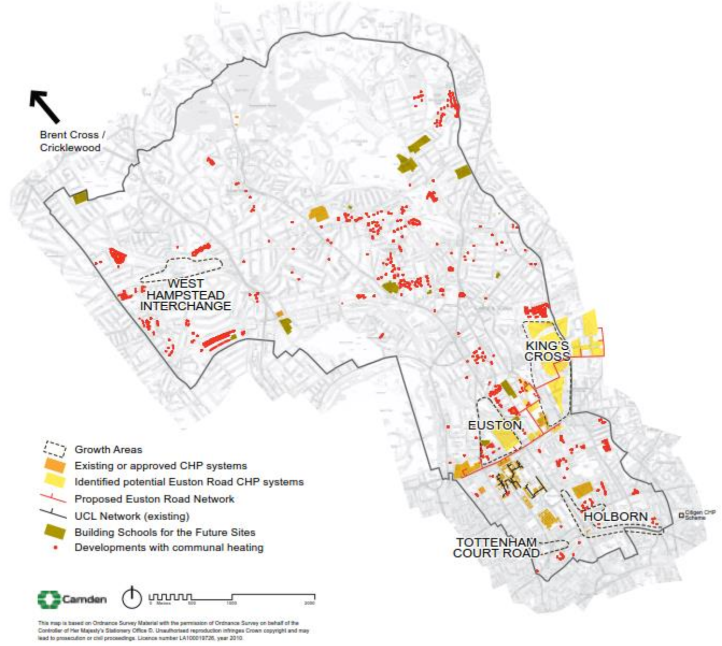
The map shows that there are no existing district heating networks in the vicinity of the development.

Figure 6-1 Excerpt from the London Heat Map Showing Existing/Proposed DHNs



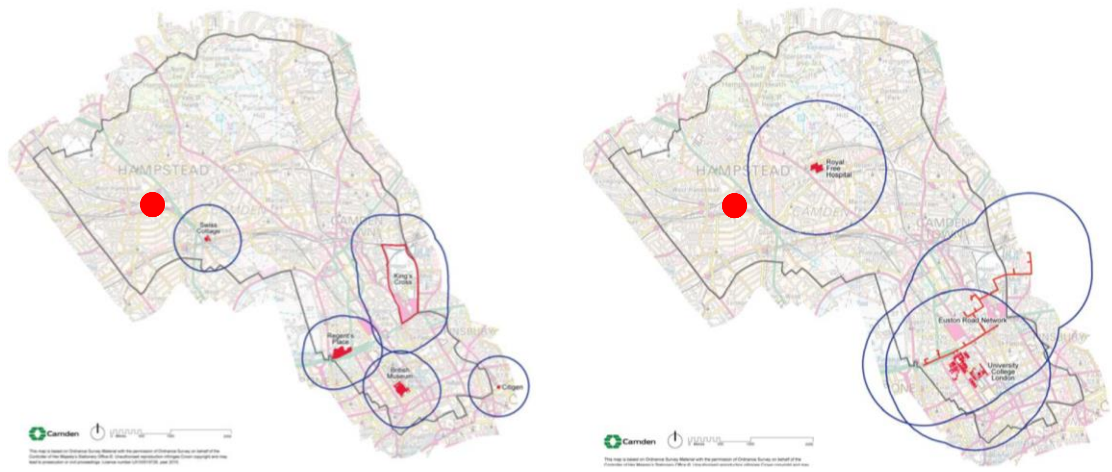
Camden's Core Strategy includes a map of existing and proposed combined heat and power networks (see Figure 6-2).

Figure 6-2 Combined Heat and Power Networks Camden



The Sustainability SPD also confirms that any proposed development falling within 500m or 1 km of an existing, emerging, or potential energy network, should undergo a connection feasibility study and possibly allow for future connections to be made. However as shown in Figure 6-3 the Proposed Development (highlighted by a red dot) falls outside of these boundaries.

Figure 6-3 Location of Existing Districts Heat Networks



Taken together this information shows that there are no local viable existing heat networks available for Canfield Place.

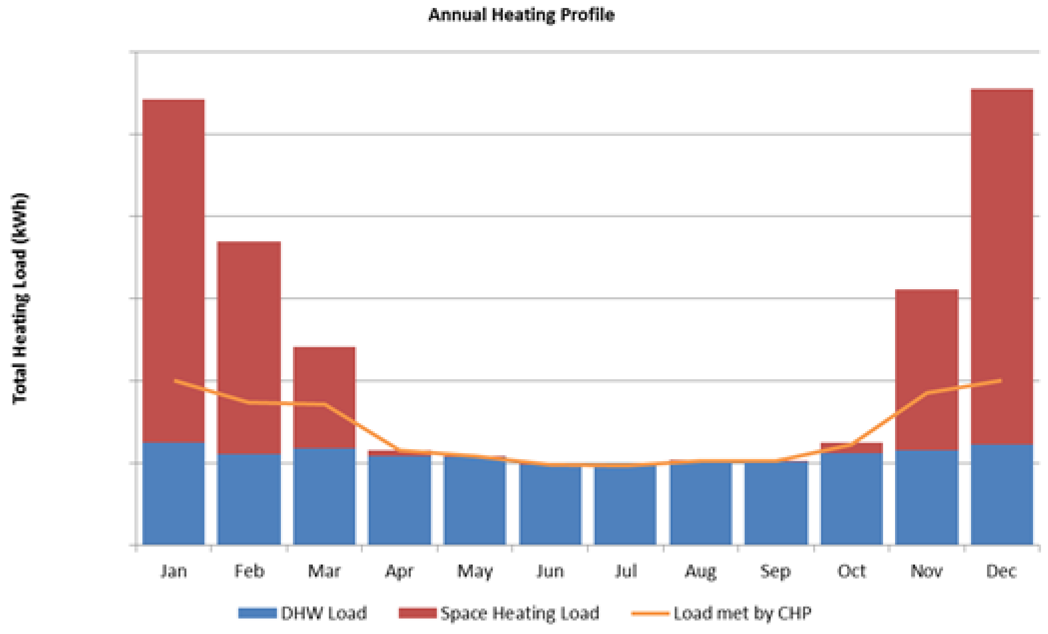
6.2 COMBINED HEAT AND POWER (CHP)

On the basis that the development cannot be supplied directly from a district heating network, in line with the requirements of Camden council, then CHP could be considered. If a centralised heat network for the 8 units was viable, then a CHP unit would have been a potential source of low carbon heat. However the combined properties do not have sufficient level of domestic water demand or consistency of space heating demand (as shown in the example graph below) to justify a central CHP led system. Therefore a CHP led system is not currently recommended for any of the buildings in the Proposed Development.

An additional issue is that proposed changes to SAP CO_2 emission factors due to take force in 2017 suggest that CHP will increase CO_2 emissions in comparison to gas fired boiler, and this is likely to be even more of an issue over the lifetime of such plant.

Figure 6-4 shows a typical annual hotel heating profile with the heat contribution from the CHP engines.

Figure 6-4 Typical Annual Heating Profile Showing Provision from a CHP Led Heating System



6.3 CARBON EMISSIONS REDUCTION

Due to the lack of justification for DHN or CHP the overall carbon emissions for the development remain at 10.11 tCO_2 as shown in Table 6-1.

Table 6-1 Be Clean: Carbon Emissions after the Provision of Energy Efficiency Supply Measures

	REGULATED EMISSIONS (TCO_2)	UNREGULATED EMISSIONS (TCO_2)	REDUCTION IN REGULATED CARBON EMISSIONS
Building Regulations Part L 2013 Compliant Development	13.40	6.57	0.00%
After energy demand reduction	10.11	6.57	24.57%
After energy efficient supply	10.11	6.57	24.57%

7 BE GREEN: RENEWABLE ENERGY TECHNOLOGIES

The final step in the energy hierarchy is to consider how renewable energy technologies can be deployed to reduce carbon emissions of the Proposed Development. Renewable energy technologies are those listed below which can provide a source of energy on-site that is not primarily based on the consumption of fossil fuels or grid electricity and/or utilises a heat source that is renewable such as air, ground and solar systems.

- Wind Power
- Biomass Heating
- Ground Source Heating and/or Cooling
- Solar Thermal Hot Water Heating
- Photovoltaic Panels

In accordance with the requirements of Section 5.2 of the London Plan and Camden Core Strategy, we have evaluated a number of renewable energy technologies and outlined how they may be applied to the development.

7.1 WIND POWER

Harnessing the kinetic energy of wind can provide a renewable source of on-site electricity generation. Wind turbines need to be positioned where a frequent and steady source of wind is available that is not too turbulent or uneven in direction. Typically wind turbines are positioned on the roof of buildings that are significantly higher than their surroundings and or located in open areas where there is minimum disruption to prevailing winds.

The development is located within an urban environment with numerous adjacent buildings of similar height providing turbulent wind conditions unsuitable for wind power generation.

Wind conditions prevent the implementation of wind power generation from being feasible. In addition, wind turbines are not considered to be appropriate in townscape and architectural terms to provide wind turbines on top of the building. On that basis they are not proposed for the Canfield Place development.

7.2 BIOMASS HEATING

Biomass heating has embodied environmental impacts from transport and fuel combustion which makes it less desirable in Air Quality Management Areas (AQMAs). A review of the potential impact on air quality from increased wood fuelled biomass use in London has been carried out by AEA Energy & Environment, and was published in December 2007. The assessment indicates that potentially increasing the contribution from small-scale wood fuelled biomass combustion may lead to a substantial increase in nitrogen dioxide and particulate matter concentrations. Further to this, solid biomass relies on a reliable fuel supply which must be delivered and stored on site. Sites using biomass solutions therefore require good access routes and space for fuel storage and plant, which could not feasibly be incorporated at Canfield Place. It also has relatively high maintenance requirements and fuel costs. This technology is therefore deemed to be unsuitable for the Proposed Development.

7.3 HEAT PUMPS

Heat pumps use electricity to turn low grade heat to a higher temperature typically suitable for LTHW applications. They work most effectively when the source temperature (whether that is external air, the ground, or a large body of water) is at a relatively high temperature while the required output temperature is relatively low, i.e. between 35^{0}C and 45^{0}C. Some heat pumps can also be reversed to provide cooling.

Heat pumps produce no emissions at point of use and so do not have an impact on air quality in the locality. Additionally their carbon emissions will reduce in line with the existing and expected decarbonisation of the national grid.

Heat pumps are measured by their coefficient of performance (CoP); that is the ratio of input electricity to the output of heat. Air source heat pumps (ASHPs) generally operate between a CoP of 2.5 and 3, while a good ground or water source heat pump (GSHP / WSHP) may operate between 3.5 – 4.5. These CoPs vary considerably depending on the local source temperatures and the building heat distribution system. This technology operates most effectively when used to provide space heating via a very low temperature systems such as underfloor heating or low temperature radiators. If higher temperatures are required, the CoP reduces. As ground temperatures are stable year round, GSHPs provide a consistent level of performance throughout the year. Whereas the coefficient of performance of air source heat pumps is directly related to the air temperature. This means the CoP of an ASHP drops in the winter, when demand is greatest but rises in the summer when heating is not normally required. Ground source heating is an effective renewable energy source when used to provide space heating via low grade heating system such as underfloor heating. However a lack of adequate space and cost leads this not to be recommended for the Proposed Development. Air source heat pumps are easily located at various points, such as roof level, and are considered suitable for this development.

7.4 SOLAR HOT WATER

Solar hot water (SHW) generation involves capturing solar radiant heat to preheat or heat domestic hot water.

Correctly located and orientated, solar thermal systems can meet a proportion of a building's domestic hot water dependent on the expected demand profile and available space for locating SHW collectors.

SHW collectors do have an aesthetic impact and this may mitigate against their use, especially considering their likely location on the southern facade. On these grounds, whilst technically feasible, potentially suitable for this Scheme.

7.5 PHOTOVOLTAIC PANELS

The feasibility of providing photovoltaic (PV) panels has been assessed based upon estimated energy production (kWh) from the installed location along with manufacturers cost data to enable a life cycle cost analysis to be undertaken. Panels correctly oriented, maintained and not obscured by shading can be expected to provide in the region of 120kWh/m^2/year in London.

Due to the significant lack of south facing roof space, PV panels would need to be mounted vertically on the southern façade which would reduce their efficiency. It has been estimated that roughly 3m^2 of PV panels per dwelling house would be required to achieve a 35% carbon reduction against Part L (2013). Although this would have a material impact aesthetically and financially, PV technology is considered potentially appropriate for this development.

7.6 SUITABILITY APPRAISAL

All renewable energy technologies which may be considered feasible for the scheme have been assessed and summarised in table 7-1.

Table 7-1 Renewable technology suitability appraisal

TECHNOLOGY		APPRAISAL
Wind		Not suitable at this site
Biomass		Not suitable at this site
Heat Pumps	Ground Source	Not suitable at this site
	Air Source	Recommended at this site
Solar Thermal		Potentially suitable at this site
Photovoltaic Panels		Potentially suitable at this site

7.7 CARBON EMISSIONS REDUCTION

All renewable energy technologies which may be considered feasible for the scheme have been assessed, the outcomes of which are summarised above. From that exercise, it was concluded that ASHPs, SHW collectors and PV panels could be suitable for inclusion in the proposals, with ASHPs being the preferred technology due to viability and buildability considerations. This result, using a candidate system (Dimplex A6M), has been reflected in table 7-2.

Camden's requirement to target a 20% reduction in CO_2 emissions from on-site renewable technologies for this project is not feasible due to the highly efficient fabric standards that were describe in stage 1 of the energy hierarchy.

Table 7-2 Be Green: Carbon Emissions Utilising Air source heat pumps

	REGULATED EMISSIONS (T CO_2)	UNREGULATED EMISSIONS (T CO_2)	% REDUCTION IN REGULATED CO_2 EMISSIONS
Building Regulations Part L 2013 Compliant Development	13.40	6.57	0.0%
After energy demand reduction	10.11	6.57	24.57%
After energy efficient supply	10.11	6.57	24.57%
After renewable energy	8.65	6.57	35.44%

8 RESULTS

The three principal steps taken; Be Lean (Use Less Energy), Be Clean (Supply Energy Efficiently) and finally Be Green (Renewable Technology measures) are summarised below. The target (Building Regulations compliant) carbon emissions for the Proposed Development are calculated to be 13.40 tCO_2 per annum.

8.1 ENERGY CONSERVATION AND ENERGY EFFICIENCY (BE LEAN)

Through the application of the fabric efficiency measures identified in Section 5 the regulated carbon emissions are shown projected to be 10.11 tCO_2 per annum.

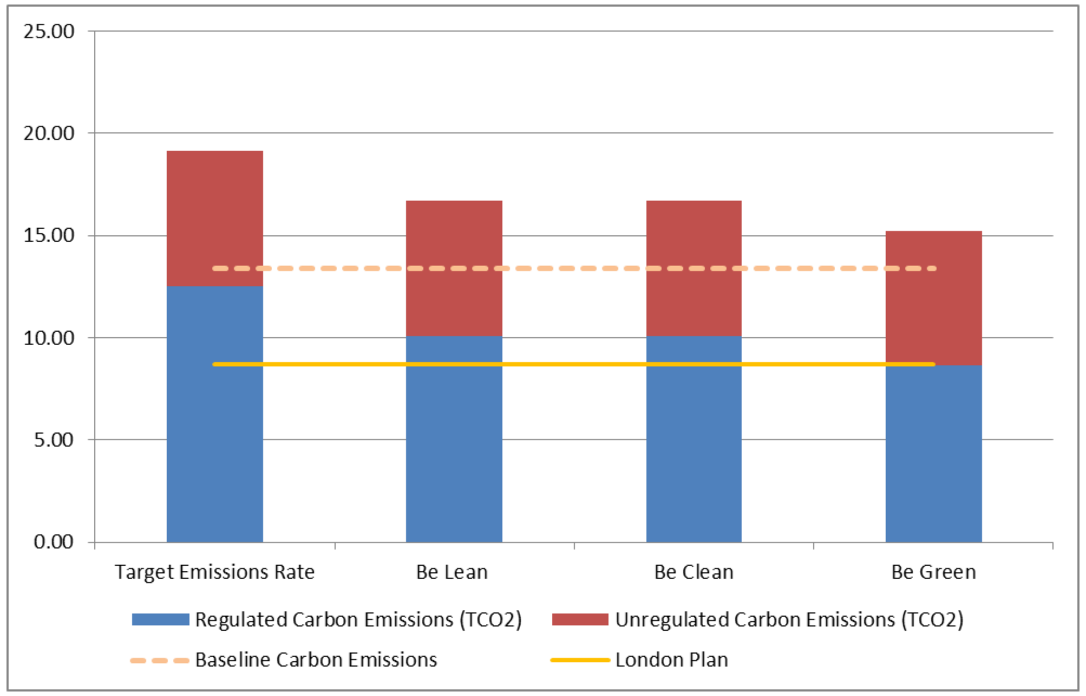
8.2 SUPPLY ENERGY EFFICIENTLY (BE CLEAN)

The application of low carbon technologies such as connection to an existing local district heating network or the installation of a combined heat and power unit, has been explored and rejected. As such the overall regulated carbon emissions remains at 10.11 tCO_2 per annum.

8.3 RENEWABLE TECHNOLOGY (BE GREEN)

Within Section 7 the feasibility of a range of renewable technologies has been assessed in the context of the London Plan. Air source heat pumps are proposed for each dwelling to provide a further reduction in overall carbon emissions. As a result the overall regulated carbon emissions are reduced to 8.65 tCO_2 per annum. This represents a 35.44% reduction in CO_2 emissions against building regulations (2013) standards.

Figure 8-1 Summary of the estimated carbon emissions reductions for the whole development



8.4 LONDON PLAN – POLICY 5.2

As discussed in section 3.1 LBC have confirmed that the GLA's Zero Carbon Homes tax will apply to Canfield Place. As such the remaining CO_2 emissions other than those reduced on-site, are to be offset down to zero. Camden charge a static rate of £90 per tonne which equates to an approximate charge of c.£23,000, although this will be finalised once detailed design is complete and subject to further calculation methodology clarifications from LBC.

APPENDIX A-1 SAP 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	Mr Harry Knibb	Assessor number	1
Client		Last modified	23/02/2017
Address	Canfield Place 12 Canfield Place, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		39.40	(1a)	x	2.90	(2a)	=	114.26	(3a)
+1		39.40	(1b)	x	2.90	(2b)	=	114.26	(3b)
+2		39.40	(1c)	x	3.10	(2c)	=	122.14	(3c)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	118.20	(4)						
Dwelling volume							(3a) + (3b) + (3c) + (3d)...(3n) =	350.66	(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	74.80	(23c)

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

0.27	0.27	0.27	0.25	0.25	0.24	0.24	0.23	0.24	0.25	0.26	0.26	(24a)

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

0.27	0.27	0.27	0.25	0.25	0.24	0.24	0.23	0.24	0.25	0.26	0.26	(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			25.04	x	1.15	=	28.67			(27)
Ground floor			39.40	x	0.11	=	4.33			(28a)
External wall			83.70	x	0.16	=	13.39			(29a)
Party wall			114.80	x	0.00	=	0.00			(32)
Roof			39.40	x	0.11	=	4.33			(30)
Total area of external elements ∑A, m²			187.54							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	50.73	(33)
Heat capacity Cm = ∑(A x κ)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
Thermal mass parameter (TMP) in kJ/m²K		250.00	(35)
Thermal bridges: ∑(L x Ψ) calculated using Appendix K		9.38	(36)
Total fabric heat loss	(33) + (36) =	60.12	(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)	31.73	31.40	31.06	29.38	29.04	27.36	27.36	27.02	28.03	29.04	29.71	30.39	(38)
Heat transfer coefficient, W/K (37)m + (38)m	91.85	91.51	91.18	89.49	89.16	87.48	87.48	87.14	88.15	89.16	89.83	90.50	
Average = ∑(39)1...12/12 =												89.41	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.78	0.77	0.77	0.76	0.75	0.74	0.74	0.74	0.75	0.75	0.76	0.77	
Average = ∑(40)1...12/12 =												0.76	(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	2.86	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	102.03	(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)	112.24	108.15	104.07	99.99	95.91	91.83	91.83	95.91	99.99	104.07	108.15	112.24	
∑(44)1...12 =												1224.38	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	166.44	145.57	150.22	130.96	125.66	108.44	100.48	115.30	116.68	135.98	148.43	161.19	
∑(45)1...12 =												1605.36	(45)
Distribution loss 0.15 x (45)m	24.97	21.84	22.53	19.64	18.85	16.27	15.07	17.30	17.50	20.40	22.27	24.18	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.41	(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)

Water storage loss calculated for each month (55) x (41)m

23.60	21.32	23.60	22.84	23.60	22.84	23.60	23.60	22.84	23.60	22.84	23.60	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

23.60	21.32	23.60	22.84	23.60	22.84	23.60	23.60	22.84	23.60	22.84	23.60	(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

213.31	187.90	197.08	176.32	172.53	153.79	147.35	162.17	162.04	182.85	193.79	208.06	(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

213.31	187.90	197.08	176.32	172.53	153.79	147.35	162.17	162.04	182.85	193.79	208.06

∑(64)1...12 = 2157.17 (64)

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

92.83	82.27	87.44	79.83	79.27	72.34	70.90	75.83	75.08	82.71	85.64	91.09	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	25.22	22.40	18.21	13.79	10.31	8.70	9.40	12.22	16.41	20.83	24.31	25.92	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	282.85	285.79	278.39	262.64	242.77	224.09	211.61	208.67	216.07	231.81	251.69	270.37	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	(71)
Water heating gains (Table 5)	124.78	122.42	117.53	110.87	106.55	100.47	95.30	101.92	104.28	111.16	118.94	122.43	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	498.69	496.44	479.97	453.15	425.47	399.10	382.15	388.66	402.59	429.65	460.78	484.56	(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	
North	0.77	x	7.84	x	10.63	x 0.9 x	0.72	x	0.80	=	33.28	(74)
South	0.77	x	17.20	x	46.75	x 0.9 x	0.72	x	0.80	=	320.99	(78)

Solar gains in watts ∑(74)m...(82)m	354.26	589.28	777.70	930.41	1022.49	1009.30	975.27	905.58	829.44	642.71	421.53	305.10	(83)
Total gains - internal and solar (73)m + (83)m	852.95	1085.73	1257.67	1383.56	1447.96	1408.40	1357.42	1294.24	1232.03	1072.36	882.31	789.66	(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	0.97	0.90	0.75	0.57	0.40	0.28	0.31	0.49	0.80	0.97	1.00	(86)

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

20.42	20.64	20.83	20.96	20.99	21.00	21.00	21.00	21.00	20.95	20.66	20.37	(87)

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

20.27	20.28	20.28	20.29	20.29	20.31	20.31	20.31	20.30	20.29	20.29	20.28	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.96	0.87	0.71	0.53	0.35	0.24	0.26	0.44	0.77	0.97	0.99	(89)

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

19.74	19.96	20.15	20.26	20.29	20.31	20.31	20.31	20.30	20.26	20.00	19.71	(90)

Living area fraction — Living area ÷ (4) = 0.26 (91)

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

19.92	20.14	20.32	20.44	20.47	20.48	20.48	20.49	20.48	20.43	20.17	19.88	(92)

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

19.92	20.14	20.32	20.44	20.47	20.48	20.48	20.49	20.48	20.43	20.17	19.88	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.96	0.88	0.72	0.54	0.37	0.25	0.28	0.46	0.77	0.96	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	843.50	1037.20	1101.61	996.76	777.52	514.46	339.73	356.01	561.24	829.56	850.23	783.98	(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]	1434.32	1394.23	1260.21	1032.83	781.97	514.68	339.75	356.03	562.32	876.68	1174.15	1419.22	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	439.57	239.92	118.00	25.97	3.32	0.00	0.00	0.00	0.00	35.06	233.22	472.62	

∑(98)1...5, 10...12 = 1567.68 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 13.26 (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 (%)		275.25	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	159.70	87.16	42.87	9.44	1.20	0.00	0.00	0.00	0.00	12.74	84.73	171.70

∑(211)1...5, 10...12 = 569.54 (211)

Water heating

Efficiency of water heater

271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	(217)

Water heating fuel, kWh/month

78.45	69.11	72.49	64.85	63.45	56.56	54.19	59.65	59.60	67.25	71.27	76.52

	∑(219a)1...12 =	793.40	(219)

Annual totals

Space heating fuel - main system 1		569.54	
Water heating fuel		793.40	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	326.20		(230a)
Total electricity for the above, kWh/year		326.20	(231)
Electricity for lighting (Appendix L)		445.33	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	2134.47	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	569.54	x	13.19	x 0.01 =	75.12	(240)
Water heating	793.40	x	13.19	x 0.01 =	104.65	(247)
Pumps and fans	326.20	x	13.19	x 0.01 =	43.03	(249)
Electricity for lighting	445.33	x	13.19	x 0.01 =	58.74	(250)
Additional standing charges					0.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		281.54	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	0.72	(257)
SAP value	89.89	
SAP rating (section 13)	90	(258)
SAP band	B	

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	569.54	x	0.519	=	295.59	(261)
Water heating	793.40	x	0.519	=	411.77	(264)
Space and water heating			(261) + (262) + (263) + (264) =		707.37	(265)
Pumps and fans	326.20	x	0.519	=	169.30	(267)
Electricity for lighting	445.33	x	0.519	=	231.13	(268)
Total CO_2, kg/year			(265)...(271) =		1107.79	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		9.37	(273)
EI value					90.90	
EI rating (section 14)					91	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	569.54	x	3.07	=	1748.50	(261)
Water heating	793.40	x	3.07	=	2435.73	(264)
Space and water heating			(261) + (262) + (263) + (264) =		4184.23	(265)
Pumps and fans	326.20	x	3.07	=	1001.44	(267)
Electricity for lighting	445.33	x	3.07	=	1367.16	(268)
Primary energy kWh/year					6552.83	(272)

Dwelling primary energy rate kWh/m2/year	55.44	(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	Mr Harry Knibb	Assessor number	1
Client		Last modified	23/02/2017
Address	Canfield Place 12 Canfield Place, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		39.40	(1a)	x	2.90	(2a)	=	114.26	(3a)
+1		39.40	(1b)	x	2.90	(2b)	=	114.26	(3b)
+2		39.40	(1c)	x	3.10	(2c)	=	122.14	(3c)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	118.20	(4)						
Dwelling volume						(3a) + (3b) + (3c) + (3d)...(3n) =		350.66	(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	4	x 10 =	40	(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) =	40	÷ (5) =	0.11	(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		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.36	(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) =	0.28	(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	0.36	0.35	0.35	0.31	0.30	0.27	0.27	0.26	0.28	0.30	0.32	0.33	(22b)

Calculate effective air change rate for the applicable case:

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

d) natural ventilation or whole house positive input ventilation from loft

0.56	0.56	0.56	0.55	0.55	0.54	0.54	0.53	0.54	0.55	0.55	0.55	(24d)

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

0.56	0.56	0.56	0.55	0.55	0.54	0.54	0.53	0.54	0.55	0.55	0.55	(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			25.04	x	1.33	=	33.20			(27)
Ground floor			39.40	x	0.13	=	5.12			(28a)
External wall			83.70	x	0.18	=	15.07			(29a)
Party wall			114.80	x	0.00	=	0.00			(32)
Roof			39.40	x	0.13	=	5.12			(30)
Total area of external elements ∑A, m²			187.54							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	58.51	(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		3.70	(36)
Total fabric heat loss	(33) + (36) =	62.21	(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)	65.35	65.06	64.77	63.43	63.18	62.02	62.02	61.80	62.47	63.18	63.69	64.22	(38)
Heat transfer coefficient, W/K (37)m + (38)m	127.56	127.27	126.98	125.64	125.39	124.23	124.23	124.01	124.68	125.39	125.90	126.43	
Average = ∑(39)1...12/12 =												125.64	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.08	1.08	1.07	1.06	1.06	1.05	1.05	1.05	1.05	1.06	1.07	1.07	
Average = ∑(40)1...12/12 =												1.06	(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	2.86	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	102.03	(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)	112.24	108.15	104.07	99.99	95.91	91.83	91.83	95.91	99.99	104.07	108.15	112.24	
∑(44)1...12 =												1224.38	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	166.44	145.57	150.22	130.96	125.66	108.44	100.48	115.30	116.68	135.98	148.43	161.19	
∑(45)1...12 =												1605.36	(45)
Distribution loss 0.15 x (45)m	24.97	21.84	22.53	19.64	18.85	16.27	15.07	17.30	17.50	20.40	22.27	24.18	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.39	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.75	(50)
Enter (50) or (54) in (55)	0.75	(55)

Water storage loss calculated for each month (55) x (41)m

23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(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

213.04	187.66	196.81	176.05	172.26	153.53	147.08	161.90	161.77	182.58	193.53	207.78	(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

213.04	187.66	196.81	176.05	172.26	153.53	147.08	161.90	161.77	182.58	193.53	207.78	

∑(64)1...12 = 2153.98 (64)

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

92.62	82.07	87.22	79.62	79.06	72.13	70.69	75.61	74.87	82.49	85.43	90.87	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	142.80	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	25.27	22.45	18.25	13.82	10.33	8.72	9.42	12.25	16.44	20.87	24.36	25.97	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	282.85	285.79	278.39	262.64	242.77	224.09	211.61	208.67	216.07	231.81	251.69	270.37	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	37.28	(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)	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	-114.24	(71)
Water heating gains (Table 5)	124.49	122.13	117.23	110.58	106.26	100.18	95.01	101.63	103.99	110.87	118.65	122.14	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	501.45	499.20	482.72	455.89	428.20	401.83	384.88	391.39	405.34	432.40	463.54	487.32	(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	
North	0.77	x	7.84	x	10.63	x 0.9 x	0.63	x	0.70	=	25.48	(74)
South	0.77	x	17.20	x	46.75	x 0.9 x	0.63	x	0.70	=	245.75	(78)

Solar gains in watts ∑(74)m...(82)m

271.23	451.17	595.43	712.35	782.84	772.74	746.69	693.34	635.04	492.07	322.73	233.59	(83)

Total gains - internal and solar (73)m + (83)m

772.68	950.37	1078.15	1168.23	1211.04	1174.57	1131.57	1084.73	1040.38	924.48	786.28	720.92	(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	0.97	0.93	0.83	0.65	0.48	0.52	0.75	0.95	0.99	1.00	(86)

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

19.91	20.11	20.36	20.65	20.87	20.97	21.00	20.99	20.94	20.65	20.22	19.87	(87)

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

20.02	20.02	20.02	20.03	20.03	20.04	20.04	20.04	20.04	20.03	20.03	20.03	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.97	0.91	0.77	0.56	0.38	0.41	0.67	0.93	0.99	1.00	(89)

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

18.56	18.86	19.23	19.63	19.91	20.02	20.04	20.04	19.99	19.65	19.02	18.51	(90)

Living area fraction — Living area ÷ (4) = 0.26 (91)

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

18.91	19.18	19.52	19.89	20.15	20.27	20.28	20.28	20.24	19.91	19.33	18.86	(92)

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

18.91	19.18	19.52	19.89	20.15	20.27	20.28	20.28	20.24	19.91	19.33	18.86	(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	0.96	0.90	0.78	0.58	0.40	0.44	0.69	0.92	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	768.37	935.52	1036.57	1056.07	946.80	685.58	455.71	478.41	720.03	853.21	775.55	718.03	(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]	1863.18	1817.21	1653.04	1381.20	1059.97	704.01	457.76	481.73	764.92	1166.86	1539.88	1853.43	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	814.54	592.49	458.65	234.10	84.20	0.00	0.00	0.00	0.00	233.36	550.32	844.74	

∑(98)1...5, 10...12 = 3812.40 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 32.25 (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 (%)		93.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	871.17	633.68	490.54	250.37	90.06	0.00	0.00	0.00	0.00	249.58	588.58	903.46

∑(211)1...5, 10...12 = 4077.44 (211)

Water heating

Efficiency of water heater

88.05	87.67	87.00	85.57	83.02	79.80	79.80	79.80	79.80	85.47	87.45	88.17	(217)

Water heating fuel, kWh/month

241.94	214.04	226.23	205.73	207.48	192.39	184.31	202.88	202.72	213.62	221.30	235.67

∑(219a)1...12 =	2548.32	(219)

Annual totals

Space heating fuel - main system 1		4077.44	
Water heating fuel		2548.32	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
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		75.00	(231)
Electricity for lighting (Appendix L)		446.29	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	7147.04	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4077.44	x	3.48	x 0.01 =	141.89	(240)
Water heating	2548.32	x	3.48	x 0.01 =	88.68	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	446.29	x	13.19	x 0.01 =	58.87	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		419.33	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.08	(257)
SAP value	84.95	
SAP rating (section 13)	85	(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	4077.44	x	0.216	=	880.73	(261)
Water heating	2548.32	x	0.216	=	550.44	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1431.16	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	446.29	x	0.519	=	231.62	(268)
Total CO_2, kg/year				(265)...(271) =	1701.71	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	21.06	(273)
EI value					86.03	
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	4077.44	x	1.22	=	4974.47	(261)
Water heating	2548.32	x	1.22	=	3108.95	(264)
Space and water heating			(261) + (262) + (263) + (264) =		8083.42	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	446.29	x	3.07	=	1370.11	(268)

Primary energy kWh/year	9683.78	(272)
Dwelling primary energy rate kWh/m2/year	81.93	(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	Mr Harry Knibb	Assessor number	1
Client		Last modified	23/02/2017
Address	18 Canfield Place HS-B2, London		

1. Overall dwelling dimensions

	Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied	40.90	(1a)	x	2.90	(2a)	=	118.61	(3a)
+1	40.90	(1b)	x	2.90	(2b)	=	118.61	(3b)
+2	2.70	(1c)	x	3.10	(2c)	=	8.37	(3c)
Total floor area (1a) + (1b) + (1c) + (1d)...(1n) =	84.50	(4)						
Dwelling volume						(3a) + (3b) + (3c) + (3d)...(3n) =	245.59	(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	74.80	(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	
0.27	0.27	0.27	0.25	0.25	0.24	0.24	0.23	0.24	0.25	0.26	0.26	(24a)

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

0.27	0.27	0.27	0.25	0.25	0.24	0.24	0.23	0.24	0.25	0.26	0.26	(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			18.75	x	1.15	=	21.47			(27)
Ground floor			40.90	x	0.11	=	4.50			(28a)
External wall			55.49	x	0.16	=	8.88			(29a)
Party wall			74.82	x	0.00	=	0.00			(32)
Roof			40.90	x	0.11	=	4.50			(30)
Total area of external elements ∑A, m²			156.04							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	39.35	(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		7.80	(36)
Total fabric heat loss	(33) + (36) =	47.15	(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)	22.22	21.99	21.75	20.58	20.34	19.16	19.16	18.93	19.63	20.34	20.81	21.28	(38)
Heat transfer coefficient, W/K (37)m + (38)m	69.37	69.14	68.90	67.72	67.49	66.31	66.31	66.07	66.78	67.49	67.96	68.43	
Average = ∑(39)1...12/12 =												67.66	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.82	0.82	0.82	0.80	0.80	0.78	0.78	0.78	0.79	0.80	0.80	0.81	
Average = ∑(40)1...12/12 =												0.80	(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	2.54	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	94.59	(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)	104.05	100.27	96.48	92.70	88.91	85.13	85.13	88.91	92.70	96.48	100.27	104.05	
∑(44)1...12 =												1135.08	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	154.30	134.95	139.26	121.41	116.50	100.53	93.15	106.89	108.17	126.06	137.61	149.43	
∑(45)1...12 =												1488.26	(45)
Distribution loss 0.15 x (45)m	23.15	20.24	20.89	18.21	17.47	15.08	13.97	16.03	16.23	18.91	20.64	22.41	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.41	(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	23.60	21.32	23.60	22.84	23.60	22.84	23.60	23.60	22.84	23.60	22.84	23.60	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

23.60	21.32	23.60	22.84	23.60	22.84	23.60	23.60	22.84	23.60	22.84	23.60	(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

201.17	177.28	186.12	166.76	163.36	145.88	140.02	153.76	153.52	172.93	182.96	196.30	(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

201.17	177.28	186.12	166.76	163.36	145.88	140.02	153.76	153.52	172.93	182.96	196.30

∑(64)1...12 = 2040.07 (64)

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

88.80	78.74	83.80	76.65	76.23	69.71	68.47	73.03	72.25	79.41	82.04	87.18	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	20.38	18.10	14.72	11.14	8.33	7.03	7.60	9.88	13.26	16.83	19.65	20.95	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	228.59	230.96	224.98	212.26	196.19	181.10	171.01	168.64	174.62	187.34	203.40	218.50	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	(71)
Water heating gains (Table 5)	119.35	117.17	112.63	106.46	102.46	96.82	92.02	98.17	100.35	106.73	113.94	117.18	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	429.46	427.37	413.47	391.00	368.12	346.09	331.78	337.82	349.36	372.05	398.13	417.76	(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	
North	0.77	x	7.84	x	10.63	x 0.9 x	0.72	x	0.80	=	33.28	(74)
South	0.77	x	10.91	x	46.75	x 0.9 x	0.72	x	0.80	=	203.60	(78)

Solar gains in watts ∑(74)m...(82)m

236.88	397.04	532.81	653.64	734.08	731.74	704.08	642.22	573.63	435.35	282.39	203.67	(83)

Total gains - internal and solar (73)m + (83)m

666.34	824.41	946.29	1044.64	1102.20	1077.83	1035.86	980.04	922.99	807.40	680.52	621.44	(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	0.89	0.75	0.56	0.39	0.28	0.31	0.50	0.80	0.97	0.99	(86)

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

20.41	20.62	20.82	20.95	20.99	21.00	21.00	21.00	21.00	20.94	20.66	20.37	(87)

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

20.24	20.24	20.24	20.25	20.25	20.27	20.27	20.27	20.26	20.25	20.25	20.24	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.95	0.87	0.71	0.52	0.35	0.23	0.26	0.44	0.76	0.96	0.99	(89)

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

19.71	19.91	20.09	20.22	20.25	20.27	20.27	20.27	20.26	20.21	19.96	19.67	(90)

Living area fraction — Living area ÷ (4) = 0.39 (91)

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

19.98	20.19	20.38	20.50	20.54	20.55	20.55	20.55	20.55	20.49	20.23	19.95	(92)

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

19.98	20.19	20.38	20.50	20.54	20.55	20.55	20.55	20.55	20.49	20.23	19.95	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.98	0.95	0.87	0.72	0.54	0.37	0.25	0.28	0.47	0.78	0.96	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	656.13	783.65	827.24	754.14	592.36	394.47	262.10	274.47	429.40	626.65	651.04	614.82	(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]	1087.83	1056.95	956.09	785.91	596.61	394.72	262.12	274.50	430.63	667.78	892.41	1077.49	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	321.19	183.65	95.87	22.87	3.17	0.00	0.00	0.00	0.00	30.60	173.79	344.23	

∑(98)1...5, 10...12 = 1175.37 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 13.91 (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 (%)		211.19	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	152.08	86.96	45.39	10.83	1.50	0.00	0.00	0.00	0.00	14.49	82.29	162.99

∑(211)1...5, 10...12 = 556.54 (211)

Water heating

Efficiency of water heater

271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	(217)

Water heating fuel, kWh/month

73.99	65.20	68.46	61.33	60.08	53.65	51.50	56.55	56.47	63.60	67.29	72.20

			∑(219a)1...12 =	750.33	(219)

Annual totals

Space heating fuel - main system 1		556.54	
Water heating fuel		750.33	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	228.46		(230a)
Total electricity for the above, kWh/year		228.46	(231)
Electricity for lighting (Appendix L)		359.90	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	1895.23	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	556.54	x	13.19	x 0.01 =	73.41	(240)
Water heating	750.33	x	13.19	x 0.01 =	98.97	(247)
Pumps and fans	228.46	x	13.19	x 0.01 =	30.13	(249)
Electricity for lighting	359.90	x	13.19	x 0.01 =	47.47	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	249.98	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	0.81	(257)
SAP value	88.69	
SAP rating (section 13)	89	(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	556.54	x	0.519	=	288.85	(261)
Water heating	750.33	x	0.519	=	389.42	(264)
Space and water heating				(261) + (262) + (263) + (264) =	678.27	(265)
Pumps and fans	228.46	x	0.519	=	118.57	(267)
Electricity for lighting	359.90	x	0.519	=	186.79	(268)
Total CO_2, kg/year				(265)...(271) =	983.62	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	11.64	(273)
EI value					89.82	
EI rating (section 14)					90	(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	556.54	x	3.07	=	1708.59	(261)
Water heating	750.33	x	3.07	=	2303.51	(264)
Space and water heating				(261) + (262) + (263) + (264) =	4012.10	(265)
Pumps and fans	228.46	x	3.07	=	701.37	(267)
Electricity for lighting	359.90	x	3.07	=	1104.88	(268)
Primary energy kWh/year					5818.35	(272)

Dwelling primary energy rate kWh/m2/year	68.86	(273)

TER Worksheet
Design - Draft

NHER

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

Assessor name	Mr Harry Knibb	Assessor number	1
Client		Last modified	23/02/2017
Address	18 Canfield Place HS-B2, London		

1. Overall dwelling dimensions

		Area (m^2)			Average storey height (m)			Volume (m^3)	
Lowest occupied		40.90	(1a)	x	2.90	(2a)	=	118.61	(3a)
+1		40.90	(1b)	x	2.90	(2b)	=	118.61	(3b)
+2		2.70	(1c)	x	3.10	(2c)	=	8.37	(3c)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	84.50	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			245.59	(5)

2. Ventilation rate

			m^3 per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	3	x 10 =	30	(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) =	30	÷ (5) =	0.12	(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		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.37	(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) =	0.29	(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	0.37	0.36	0.35	0.32	0.31	0.27	0.27	0.27	0.29	0.31	0.32	0.34	(22b)

Calculate effective air change rate for the applicable case:

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

d) natural ventilation or whole house positive input ventilation from loft

0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(24d)

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

0.57	0.56	0.56	0.55	0.55	0.54	0.54	0.54	0.54	0.55	0.55	0.56	(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			18.75	x	1.33	=	24.86			(27)
Ground floor			40.90	x	0.13	=	5.32			(28a)
External wall			55.49	x	0.18	=	9.99			(29a)
Party wall			74.82	x	0.00	=	0.00			(32)
Roof			40.90	x	0.13	=	5.32			(30)
Total area of external elements ∑A, m²			156.04							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	45.48	(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		2.62	(36)
Total fabric heat loss	(33) + (36) =	48.10	(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)	46.00	45.79	45.58	44.60	44.42	43.56	43.56	43.41	43.89	44.42	44.79	45.18	(38)
Heat transfer coefficient, W/K (37)m + (38)m	94.10	93.89	93.68	92.70	92.51	91.66	91.66	91.50	91.99	92.51	92.88	93.27	
Average = ∑(39)1...12/12 =												92.70	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.11	1.11	1.11	1.10	1.09	1.08	1.08	1.08	1.09	1.09	1.10	1.10	
Average = ∑(40)1...12/12 =												1.10	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	2.54	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	94.59	(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)	104.05	100.27	96.48	92.70	88.91	85.13	85.13	88.91	92.70	96.48	100.27	104.05	
∑(44)1...12 =												1135.08	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	154.30	134.95	139.26	121.41	116.50	100.53	93.15	106.89	108.17	126.06	137.61	149.43	
∑(45)1...12 =												1488.26	(45)
Distribution loss 0.15 x (45)m	23.15	20.24	20.89	18.21	17.47	15.08	13.97	16.03	16.23	18.91	20.64	22.41	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.39	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.75	(50)
Enter (50) or (54) in (55)	0.75	(55)

Water storage loss calculated for each month (55) x (41)m

23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(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

200.90	177.04	185.85	166.50	163.09	145.62	139.75	153.49	153.26	172.66	182.70	196.03	(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

200.90	177.04	185.85	166.50	163.09	145.62	139.75	153.49	153.26	172.66	182.70	196.03

∑(64)1...12 = 2036.88 (64)

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

88.58	78.54	83.58	76.44	76.01	69.50	68.25	72.82	72.04	79.19	81.83	86.96	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	127.14	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	20.38	18.10	14.72	11.15	8.33	7.03	7.60	9.88	13.26	16.84	19.65	20.95	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	228.59	230.96	224.98	212.26	196.19	181.10	171.01	168.64	174.62	187.34	203.40	218.50	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	35.71	(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)	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	-101.71	(71)
Water heating gains (Table 5)	119.06	116.88	112.34	106.17	102.16	96.53	91.73	97.87	100.06	106.44	113.65	116.88	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	432.17	430.08	416.18	393.71	370.83	348.80	334.48	340.53	352.07	374.76	400.85	420.48	(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	
North	0.77	x	7.84	x	10.63	x 0.9 x	0.63	x	0.70	=	25.48	(74)
South	0.77	x	10.91	x	46.75	x 0.9 x	0.63	x	0.70	=	155.88	(78)

Solar gains in watts ∑(74)m...(82)m

181.36	303.98	407.94	500.44	562.03	560.24	539.06	491.70	439.18	333.32	216.20	155.94	(83)

Total gains - internal and solar (73)m + (83)m

613.53	734.06	824.12	894.15	932.86	909.04	873.55	832.23	791.26	708.08	617.05	576.41	(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	0.97	0.92	0.80	0.62	0.46	0.50	0.74	0.94	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.92	20.12	20.37	20.66	20.88	20.98	21.00	20.99	20.94	20.67	20.24	19.89	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	19.99	19.99	19.99	20.00	20.01	20.01	20.01	20.01	20.01	20.01	20.00	20.00	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.98	0.96	0.89	0.75	0.54	0.36	0.40	0.65	0.91	0.98	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	18.57	18.85	19.22	19.62	19.89	20.00	20.01	20.01	19.97	19.64	19.03	18.52	(90)

Living area fraction — Living area ÷ (4) = 0.39 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	19.10	19.35	19.67	20.03	20.27	20.38	20.40	20.40	20.35	20.04	19.50	19.05	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	19.10	19.35	19.67	20.03	20.27	20.38	20.40	20.40	20.35	20.04	19.50	19.05	(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	0.96	0.89	0.76	0.57	0.40	0.44	0.68	0.91	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	608.49	719.62	787.15	798.28	713.27	516.44	346.31	362.91	540.77	646.68	605.74	572.86	(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]	1392.54	1356.39	1233.58	1031.59	793.30	529.74	347.95	365.60	574.68	873.17	1151.90	1385.51	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	583.33	427.91	332.14	167.98	59.54	0.00	0.00	0.00	0.00	168.51	393.23	604.61	

∑(98)1...5, 10...12 = 2737.26 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 32.39 (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 (%)		93.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	623.89	457.66	355.23	179.66	63.68	0.00	0.00	0.00	0.00	180.22	420.57	646.64

∑(211)1...5, 10...12 = 2927.55 (211)

Water heating

Efficiency of water heater	87.49	87.08	86.35	84.84	82.41	79.80	79.80	79.80	79.80	84.75	86.81	87.62	(217)
Water heating fuel, kWh/month	229.61	203.30	215.24	196.26	197.91	182.48	175.12	192.34	192.06	203.73	210.46	223.72	

	∑(219a)1...12 = 2422.23	(219)

Annual totals

Space heating fuel - main system 1		2927.55	
Water heating fuel		2422.23	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
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		75.00	(231)
Electricity for lighting (Appendix L)		359.93	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	5784.72	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2927.55	x	3.48	x 0.01 =	101.88	(240)
Water heating	2422.23	x	3.48	x 0.01 =	84.29	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	359.93	x	13.19	x 0.01 =	47.48	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		363.54	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.18	(257)
SAP value	83.55	
SAP rating (section 13)	84	(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	2927.55	x	0.216	=	632.35	(261)
Water heating	2422.23	x	0.216	=	523.20	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1155.55	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	359.93	x	0.519	=	186.81	(268)
Total CO_2, kg/year			(265)...(271) =		1381.28	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		23.87	(273)
EI value					85.71	
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	2927.55	x	1.22	=	3571.61	(261)
Water heating	2422.23	x	1.22	=	2955.12	(264)
Space and water heating			(261) + (262) + (263) + (264) =		6526.73	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	359.93	x	3.07	=	1105.00	(268)

Primary energy kWh/year	7861.98	(272)
Dwelling primary energy rate kWh/m2/year	93.04	(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	Mr Harry Knibb	Assessor number	1
Client		Last modified	27/02/2017
Address	20 Canfield Place HS-C1, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		42.30	(1a)	x	2.90	(2a)	=	122.67	(3a)
+1		42.30	(1b)	x	2.90	(2b)	=	122.67	(3b)
+2		42.30	(1c)	x	2.90	(2c)	=	122.67	(3c)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	126.90	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			368.01	(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	74.80	(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	
0.27	0.27	0.27	0.25	0.25	0.24	0.24	0.23	0.24	0.25	0.26	0.26	(24a)

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

0.27	0.27	0.27	0.25	0.25	0.24	0.24	0.23	0.24	0.25	0.26	0.26	(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			29.29	x	1.15	=	33.54			(27)
Ground floor			42.30	x	0.11	=	4.65			(28a)
External wall			90.77	x	0.16	=	14.52			(29a)
Party wall			107.88	x	0.00	=	0.00			(32)
Roof			42.30	x	0.11	=	4.65			(30)
Total area of external elements ∑A, m²			204.66							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	57.37	(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		10.24	(36)
Total fabric heat loss	(33) + (36) =	67.60	(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)	33.30	32.95	32.60	30.83	30.48	28.71	28.71	28.36	29.42	30.48	31.18	31.89	(38)
Heat transfer coefficient, W/K (37)m + (38)m	100.91	100.55	100.20	98.44	98.08	96.32	96.32	95.97	97.02	98.08	98.79	99.50	
Average = ∑(39)1...12/12 =												98.35	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	0.80	0.79	0.79	0.78	0.77	0.76	0.76	0.76	0.76	0.77	0.78	0.78	
Average = ∑(40)1...12/12 =												0.78	(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	2.89	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	102.75	(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)	113.03	108.92	104.81	100.70	96.59	92.48	92.48	96.59	100.70	104.81	108.92	113.03	
∑(44)1...12 =												1233.05	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	167.62	146.60	151.28	131.89	126.55	109.20	101.19	116.12	117.51	136.94	149.48	162.33	
∑(45)1...12 =												1616.72	(45)
Distribution loss 0.15 x (45)m	25.14	21.99	22.69	19.78	18.98	16.38	15.18	17.42	17.63	20.54	22.42	24.35	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.41	(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)

Water storage loss calculated for each month (55) x (41)m

23.60	21.32	23.60	22.84	23.60	22.84	23.60	23.60	22.84	23.60	22.84	23.60	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	23.60	21.32	23.60	22.84	23.60	22.84	23.60	23.60	22.84	23.60	22.84	23.60	(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	214.48	188.93	198.14	177.24	173.42	154.56	148.06	162.99	162.86	183.81	194.84	209.20	(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	214.48	188.93	198.14	177.24	173.42	154.56	148.06	162.99	162.86	183.81	194.84	209.20	
											∑(64)1...12 =	2168.52	(64)
Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]	93.23	82.61	87.79	80.14	79.57	72.59	71.14	76.10	75.35	83.03	85.99	91.47	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	26.21	23.28	18.93	14.33	10.71	9.04	9.77	12.70	17.05	21.65	25.27	26.93	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	293.94	296.99	289.31	272.94	252.29	232.87	219.90	216.85	224.54	240.90	261.56	280.97	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	(69)
Pump and fan gains (Table 5a)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	(71)
Water heating gains (Table 5)	125.30	122.93	118.00	111.30	106.95	100.82	95.62	102.29	104.66	111.59	119.43	122.94	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	511.75	509.50	492.53	464.87	436.25	409.04	391.59	398.14	412.55	440.44	472.55	497.15	(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	
North	0.77	x	7.84	x	10.63	x 0.9 x	0.72	x	0.80	=	33.28	(74)
South	0.77	x	21.45	x	46.75	x 0.9 x	0.72	x	0.80	=	400.30	(78)

Solar gains in watts ∑(74)m...(82)m	433.58	719.18	943.16	1117.42	1217.36	1196.84	1158.51	1083.53	1002.29	782.81	515.54	373.64	(83)
Total gains - internal and solar (73)m + (83)m	945.33	1228.68	1435.70	1582.29	1653.61	1605.88	1550.10	1481.68	1414.83	1223.25	988.09	870.78	(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	0.88	0.72	0.55	0.38	0.27	0.30	0.47	0.78	0.97	0.99	(86)

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

20.41	20.65	20.85	20.96	20.99	21.00	21.00	21.00	21.00	20.95	20.67	20.36	(87)

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

20.26	20.26	20.26	20.27	20.28	20.29	20.29	20.29	20.28	20.28	20.27	20.27	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.95	0.85	0.69	0.51	0.34	0.23	0.25	0.42	0.74	0.96	0.99	(89)

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

19.72	19.96	20.14	20.25	20.27	20.29	20.29	20.29	20.28	20.24	19.99	19.69	(90)

Living area fraction — Living area ÷ (4) = 0.26 (91)

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

19.90	20.14	20.33	20.44	20.46	20.47	20.47	20.48	20.47	20.43	20.17	19.86	(92)

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

19.90	20.14	20.33	20.44	20.46	20.47	20.47	20.48	20.47	20.43	20.17	19.86	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.95	0.86	0.70	0.52	0.35	0.24	0.26	0.44	0.75	0.96	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	933.47	1163.42	1229.98	1101.28	855.07	565.52	373.12	391.10	616.98	918.52	946.97	863.80	(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]	1574.41	1532.41	1385.35	1135.47	859.35	565.75	373.13	391.12	617.99	963.93	1290.74	1558.34	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	476.86	247.96	115.59	24.61	3.18	0.00	0.00	0.00	0.00	33.79	247.52	516.74	

∑(98)1...5, 10...12 = 1666.25 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 13.13 (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 (%)		301.08	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	158.38	82.36	38.39	8.17	1.06	0.00	0.00	0.00	0.00	11.22	82.21	171.63

∑(211)1...5, 10...12 = 553.43 (211)

Water heating

Efficiency of water heater

271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	(217)

Water heating fuel, kWh/month

78.89	69.49	72.88	65.19	63.78	56.85	54.46	59.95	59.90	67.60	71.66	76.94

	∑(219a)1...12 =	797.57	(219)

Annual totals

Space heating fuel - main system 1		553.43	
Water heating fuel		797.57	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	342.34		(230a)
Total electricity for the above, kWh/year		342.34	(231)
Electricity for lighting (Appendix L)		462.79	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	2156.14	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	553.43	x	13.19	x 0.01 =	73.00	(240)
Water heating	797.57	x	13.19	x 0.01 =	105.20	(247)
Pumps and fans	342.34	x	13.19	x 0.01 =	45.15	(249)
Electricity for lighting	462.79	x	13.19	x 0.01 =	61.04	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	284.39	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	0.69	(257)
SAP value	90.31	
SAP rating (section 13)	90	(258)
SAP band	B	

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

	Energy kWh/year		Emission factor kg CO_2/kWh		Emissions kg CO_2/year	
Space heating - main system 1	553.43	x	0.519	=	287.23	(261)
Water heating	797.57	x	0.519	=	413.94	(264)
Space and water heating				(261) + (262) + (263) + (264) =	701.17	(265)
Pumps and fans	342.34	x	0.519	=	177.68	(267)
Electricity for lighting	462.79	x	0.519	=	240.19	(268)
Total CO_2, kg/year				(265)...(271) =	1119.04	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	8.82	(273)
EI value					91.28	
EI rating (section 14)					91	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	553.43	x	3.07	=	1699.03	(261)
Water heating	797.57	x	3.07	=	2448.55	(264)
Space and water heating				(261) + (262) + (263) + (264) =	4147.59	(265)
Pumps and fans	342.34	x	3.07	=	1050.99	(267)
Electricity for lighting	462.79	x	3.07	=	1420.78	(268)
Primary energy kWh/year					6619.35	(272)

Dwelling primary energy rate kWh/m2/year	52.16	(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	Mr Harry Knibb	Assessor number	1
Client		Last modified	27/02/2017
Address	20 Canfield Place HS-C1, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		42.30	(1a)	x	2.90	(2a)	=	122.67	(3a)
+1		42.30	(1b)	x	2.90	(2b)	=	122.67	(3b)
+2		42.30	(1c)	x	2.90	(2c)	=	122.67	(3c)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	126.90	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			368.01	(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		4	x 10 =	40	(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) =	40	÷ (5) =	0.11	(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		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.36	(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) =	0.28	(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	0.35	0.35	0.34	0.31	0.30	0.26	0.26	0.26	0.28	0.30	0.31	0.33	(22b)

Calculate effective air change rate for the applicable case:

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

d) natural ventilation or whole house positive input ventilation from loft

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(24d)

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

0.56	0.56	0.56	0.55	0.54	0.53	0.53	0.53	0.54	0.54	0.55	0.55	(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			29.29	x	1.33	=	38.83			(27)
Ground floor			42.30	x	0.13	=	5.50			(28a)
External wall			90.77	x	0.18	=	16.34			(29a)
Party wall			107.88	x	0.00	=	0.00			(32)
Roof			42.30	x	0.13	=	5.50			(30)
Total area of external elements ∑A, m²			204.66							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	66.17	(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		4.37	(36)
Total fabric heat loss	(33) + (36) =	70.54	(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)	68.35	68.05	67.76	66.40	66.14	64.96	64.96	64.74	65.41	66.14	66.66	67.20	(38)
Heat transfer coefficient, W/K (37)m + (38)m	138.89	138.59	138.30	136.94	136.68	135.49	135.49	135.27	135.95	136.68	137.20	137.74	

Average = ∑(39)1...12/12 = 136.94 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.09	1.09	1.09	1.08	1.08	1.07	1.07	1.07	1.07	1.08	1.08	1.09	

Average = ∑(40)1...12/12 = 1.08 (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	2.89	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	102.75	(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)	113.03	108.92	104.81	100.70	96.59	92.48	92.48	96.59	100.70	104.81	108.92	113.03	

∑(44)1...12 = 1233.05 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	167.62	146.60	151.28	131.89	126.55	109.20	101.19	116.12	117.51	136.94	149.48	162.33	

∑(45)1...12 = 1616.72 (45)

Distribution loss 0.15 x (45)m	25.14	21.99	22.69	19.78	18.98	16.38	15.18	17.42	17.63	20.54	22.42	24.35	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.39	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.75	(50)
Enter (50) or (54) in (55)	0.75	(55)

Water storage loss calculated for each month (55) x (41)m	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(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

214.21	188.69	197.87	176.98	173.15	154.30	147.79	162.72	162.60	183.54	194.58	208.92	(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

214.21	188.69	197.87	176.98	173.15	154.30	147.79	162.72	162.60	183.54	194.58	208.92

∑(64)1...12 = 2165.34 (64)

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

93.01	82.41	87.58	79.93	79.35	72.38	70.92	75.89	75.14	82.81	85.78	91.25	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)													
	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	144.32	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	26.21	23.28	18.93	14.33	10.71	9.04	9.77	12.70	17.05	21.65	25.27	26.93	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	293.94	296.99	289.31	272.94	252.29	232.87	219.90	216.85	224.54	240.90	261.56	280.97	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	37.43	(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)													
	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	-115.46	(71)
Water heating gains (Table 5)													
	125.01	122.64	117.71	111.01	106.66	100.53	95.33	102.00	104.37	111.30	119.13	122.65	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	514.46	512.21	495.24	467.58	438.96	411.75	394.30	400.85	415.25	443.15	475.26	499.85	(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	
North	0.77	x	7.84	x	10.63	x 0.9 x	0.63	x	0.70	=	25.48	(74)
South	0.77	x	21.45	x	46.75	x 0.9 x	0.63	x	0.70	=	306.48	(78)

Solar gains in watts ∑(74)m...(82)m

331.96	550.62	722.11	855.52	932.05	916.33	886.99	829.58	767.37	599.34	394.71	286.07	(83)

Total gains - internal and solar (73)m + (83)m

846.42	1062.83	1217.35	1323.10	1371.00	1328.08	1281.29	1230.43	1182.63	1042.49	869.97	785.92	(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	0.97	0.92	0.81	0.63	0.46	0.50	0.73	0.94	0.99	1.00	(86)

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

19.90	20.12	20.38	20.67	20.88	20.98	21.00	20.99	20.94	20.67	20.22	19.85	(87)

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

20.01	20.01	20.01	20.02	20.02	20.03	20.03	20.03	20.02	20.02	20.02	20.01	(88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.96	0.89	0.75	0.54	0.36	0.40	0.65	0.92	0.99	1.00	(89)

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

18.54	18.86	19.24	19.64	19.91	20.01	20.03	20.03	19.98	19.65	19.01	18.48	(90)

Living area fraction — Living area ÷ (4) = 0.26 (91)

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

18.89	19.19	19.54	19.91	20.16	20.26	20.28	20.28	20.23	19.92	19.33	18.84	(92)

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

18.89	19.19	19.54	19.91	20.16	20.26	20.28	20.28	20.23	19.92	19.33	18.84	(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	0.89	0.76	0.56	0.39	0.42	0.67	0.91	0.98	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m	841.27	1043.53	1162.33	1178.25	1044.53	749.29	496.38	521.40	790.88	951.11	856.70	782.55	(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]	2026.72	1980.18	1803.37	1507.83	1156.06	767.18	498.36	524.58	833.93	1273.55	1677.56	2016.46	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	881.97	629.43	476.94	237.30	82.99	0.00	0.00	0.00	0.00	239.89	591.02	918.03	

∑(98)1...5, 10...12 = 4057.56 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 31.97 (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 (%)		93.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	943.29	673.19	510.09	253.80	88.75	0.00	0.00	0.00	0.00	256.57	632.10	981.85

∑(211)1...5, 10...12 = 4339.64 (211)

Water heating

Efficiency of water heater

88.19	87.79	87.08	85.60	82.98	79.80	79.80	79.80	79.80	85.53	87.59	88.30	(217)

Water heating fuel, kWh/month

242.90	214.94	227.24	206.76	208.66	193.35	185.20	203.90	203.76	214.59	222.14	236.59

∑(219a)1...12 =	2560.05	(219)

Annual totals

Space heating fuel - main system 1			4339.64	
Water heating fuel			2560.05	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
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			75.00	(231)
Electricity for lighting (Appendix L)			462.79	(232)
Total delivered energy for all uses		(211)...(221) + (231) + (232)...(237b) =	7437.48	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4339.64	x	3.48	x 0.01 =	151.02	(240)
Water heating	2560.05	x	3.48	x 0.01 =	89.09	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	462.79	x	13.19	x 0.01 =	61.04	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	431.04	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.05	(257)
SAP value	85.31	
SAP rating (section 13)	85	(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	4339.64	x	0.216	=	937.36	(261)
Water heating	2560.05	x	0.216	=	552.97	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1490.33	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	462.79	x	0.519	=	240.19	(268)
Total CO_2, kg/year				(265)...(271) =	1769.45	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	20.40	(273)
EI value					86.21	
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	4339.64	x	1.22	=	5294.36	(261)
Water heating	2560.05	x	1.22	=	3123.26	(264)
Space and water heating				(261) + (262) + (263) + (264) =	8417.61	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	462.79	x	3.07	=	1420.78	(268)

Primary energy kWh/year	10068.64	(272)
Dwelling primary energy rate kWh/m2/year	79.34	(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	Mr Harry Knibb	Assessor number	1
Client		Last modified	23/02/2017
Address	24 Canfield Place HS-D, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		52.90	(1a)	x	2.90	(2a)	=	153.41	(3a)
+1		52.90	(1b)	x	2.90	(2b)	=	153.41	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	105.80	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			306.82	(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		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.13	(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	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	(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	74.80	(23c)

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

0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28	(24a)

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

0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28	(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			24.44	x	1.15	=	27.98			(27)
Ground floor			52.90	x	0.11	=	5.82			(28a)
External wall			112.22	x	0.16	=	17.96			(29a)
Party wall			45.46	x	0.00	=	0.00			(32)
Roof			52.90	x	0.11	=	5.82			(30)
Total area of external elements ∑A, m²			242.46							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	57.58	(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		12.12	(36)
Total fabric heat loss	(33) + (36) =	69.70	(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)	29.22	28.89	28.57	26.96	26.64	25.02	25.02	24.70	25.67	26.64	27.28	27.93	(38)
Heat transfer coefficient, W/K (37)m + (38)m	98.92	98.59	98.27	96.66	96.33	94.72	94.72	94.40	95.37	96.33	96.98	97.62	

Average = ∑(39)1...12/12 = 96.58 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	0.93	0.93	0.93	0.91	0.91	0.90	0.90	0.89	0.90	0.91	0.92	0.92

Average = ∑(40)1...12/12 = 0.91 (40)

Number of days in month (Table 1a)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	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	2.79	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	100.39	(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)	110.43	106.42	102.40	98.39	94.37	90.35	90.35	94.37	98.39	102.40	106.42	110.43	

∑(44)1...12 = 1204.73 (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)	163.77	143.23	147.80	128.86	123.64	106.70	98.87	113.45	114.81	133.80	146.05	158.60	

∑(45)1...12 = 1579.59 (45)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Distribution loss 0.15 x (45)m	24.57	21.49	22.17	19.33	18.55	16.00	14.83	17.02	17.22	20.07	21.91	23.79	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.41	(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	23.60	21.32	23.60	22.84	23.60	22.84	23.60	23.60	22.84	23.60	22.84	23.60	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

23.60	21.32	23.60	22.84	23.60	22.84	23.60	23.60	22.84	23.60	22.84	23.60	(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

210.64	185.56	194.67	174.21	170.51	152.05	145.73	160.32	160.16	180.66	191.41	205.47	(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

210.64	185.56	194.67	174.21	170.51	152.05	145.73	160.32	160.16	180.66	191.41	205.47

∑(64)1...12 = 2131.40 (64)

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

91.95	81.49	86.64	79.13	78.60	71.76	70.37	75.22	74.46	81.98	84.85	90.23	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)													
	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	23.66	21.01	17.09	12.94	9.67	8.16	8.82	11.47	15.39	19.54	22.81	24.32	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	265.38	268.13	261.19	246.42	227.77	210.24	198.53	195.78	202.72	217.49	236.14	253.67	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	(69)
Pump and fan gains (Table 5a)													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(70)
Losses e.g. evaporation (Table 5)													
	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	(71)
Water heating gains (Table 5)													
	123.58	121.26	116.45	109.90	105.65	99.67	94.58	101.10	103.41	110.19	117.84	121.27	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	477.43	475.22	459.54	434.06	407.90	382.88	366.74	373.15	386.33	412.03	441.60	464.07	(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	
South	0.77	x	13.06	x	46.75	x 0.9 x	0.72	x	0.80	=	243.72	(78)
East	0.77	x	1.22	x	19.64	x 0.9 x	0.72	x	0.80	=	9.56	(76)
West	0.77	x	10.16	x	19.64	x 0.9 x	0.72	x	0.80	=	79.65	(80)

Solar gains in watts ∑(74)m...(82)m

332.94	573.68	795.88	993.85	1112.57	1102.19	1063.75	976.90	865.42	637.62	400.14	283.97	(83)

Total gains - internal and solar (73)m + (83)m

810.37	1048.90	1255.41	1427.92	1520.46	1485.07	1430.49	1350.05	1251.76	1049.65	841.74	748.03	(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	0.97	0.91	0.76	0.58	0.41	0.29	0.32	0.52	0.84	0.98	1.00	(86)

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

20.22	20.47	20.73	20.92	20.99	21.00	21.00	21.00	20.99	20.89	20.51	20.17	(87)

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

20.14	20.14	20.14	20.16	20.16	20.17	20.17	20.17	20.17	20.16	20.15	20.15	(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.96	0.88	0.72	0.53	0.35	0.24	0.26	0.46	0.80	0.97	0.99	(89)

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

19.43	19.68	19.93	20.10	20.15	20.17	20.17	20.17	20.16	20.08	19.73	19.40	(90)

Living area fraction — Living area ÷ (4) = 0.21 (91)

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

19.60	19.85	20.10	20.27	20.33	20.35	20.35	20.35	20.34	20.25	19.90	19.56	(92)

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

19.60	19.85	20.10	20.27	20.33	20.35	20.35	20.35	20.34	20.25	19.90	19.56	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.96	0.88	0.73	0.54	0.37	0.25	0.28	0.47	0.80	0.97	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	801.10	1005.10	1107.47	1037.95	821.36	543.50	354.78	372.60	591.70	841.64	814.09	742.28	(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]	1513.32	1473.97	1336.35	1099.40	831.04	544.21	354.83	372.69	594.97	929.67	1240.97	1499.52	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	529.89	315.08	170.29	44.24	7.20	0.00	0.00	0.00	0.00	65.49	307.35	563.38	

∑(98)1...5, 10...12 = 2002.94 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 18.93 (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 (%)		295.98	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	179.03	106.45	57.53	14.95	2.43	0.00	0.00	0.00	0.00	22.13	103.84	190.35	

∑(211)1...5, 10...12 = 676.72 (211)

Water heating

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Efficiency of water heater	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	271.89	(217)
Water heating fuel, kWh/month	77.47	68.25	71.60	64.08	62.71	55.92	53.60	58.96	58.91	66.45	70.40	75.57	

			∑(219a)1...12 =	783.92	(219)

Annual totals

Space heating fuel - main system 1		676.72	
Water heating fuel		783.92	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	285.42		(230a)
Total electricity for the above, kWh/year		285.42	(231)
Electricity for lighting (Appendix L)		417.82	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	2163.87	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	676.72	x	13.19	x 0.01 =	89.26	(240)
Water heating	783.92	x	13.19	x 0.01 =	103.40	(247)
Pumps and fans	285.42	x	13.19	x 0.01 =	37.65	(249)
Electricity for lighting	417.82	x	13.19	x 0.01 =	55.11	(250)
Additional standing charges					0.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		285.42	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	0.79	(257)
SAP value	88.91	
SAP rating (section 13)	89	(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	676.72	x	0.519	=	351.22	(261)
Water heating	783.92	x	0.519	=	406.85	(264)
Space and water heating			(261) + (262) + (263) + (264) =		758.07	(265)
Pumps and fans	285.42	x	0.519	=	148.13	(267)
Electricity for lighting	417.82	x	0.519	=	216.85	(268)
Total CO_2, kg/year			(265)...(271) =		1123.05	(272)
Dwelling CO_2 emission rate			(272) ÷ (4) =		10.61	(273)
EI value					90.02	
EI rating (section 14)					90	(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	676.72	x	3.07	=	2077.52	(261)
Water heating	783.92	x	3.07	=	2406.63	(264)
Space and water heating			(261) + (262) + (263) + (264) =		4484.15	(265)
Pumps and fans	285.42	x	3.07	=	876.24	(267)
Electricity for lighting	417.82	x	3.07	=	1282.70	(268)
Primary energy kWh/year					6643.09	(272)

Dwelling primary energy rate kWh/m2/year	62.79	(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	Mr Harry Knibb	Assessor number	1
Client		Last modified	23/02/2017
Address	24 Canfield Place HS-D, London		

1. Overall dwelling dimensions

		Area (m²)			Average storey height (m)			Volume (m³)	
Lowest occupied		52.90	(1a)	x	2.90	(2a)	=	153.41	(3a)
+1		52.90	(1b)	x	2.90	(2b)	=	153.41	(3b)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	105.80	(4)						
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) =			306.82	(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	4	x 10 =	40	(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) =	40	÷ (5) =	0.13	(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		5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)		0.38	(18)
Number of sides on which the dwelling is sheltered		2	(19)
Shelter factor	1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) =	0.32	(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	0.41	0.40	0.40	0.36	0.35	0.31	0.31	0.30	0.32	0.35	0.36	0.38	(22b)

Calculate effective air change rate for the applicable case:

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

d) natural ventilation or whole house positive input ventilation from loft

0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.57	0.57	(24d)

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

0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.57	0.57	(25)

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²		U-value W/m²K		A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K	
Window			24.44	x	1.33	=	32.40			(27)
Ground floor			52.90	x	0.13	=	6.88			(28a)
External wall			112.22	x	0.18	=	20.20			(29a)
Party wall			45.46	x	0.00	=	0.00			(32)
Roof			52.90	x	0.13	=	6.88			(30)
Total area of external elements ∑A, m²			242.46							(31)

Fabric heat loss, W/K = ∑(A × U)	(26)...(30) + (32) =	66.36	(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		3.79	(36)
Total fabric heat loss	(33) + (36) =	70.15	(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)	59.23	58.89	58.57	57.03	56.74	55.40	55.40	55.15	55.92	56.74	57.32	57.93	(38)
Heat transfer coefficient, W/K (37)m + (38)m	129.38	129.04	128.71	127.18	126.89	125.55	125.55	125.30	126.07	126.89	127.47	128.08	
Average = ∑(39)1...12/12 =												127.18	(39)
Heat loss parameter (HLP), W/m²K (39)m ÷ (4)	1.22	1.22	1.22	1.20	1.20	1.19	1.19	1.18	1.19	1.20	1.20	1.21	
Average = ∑(40)1...12/12 =												1.20	(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	2.79	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	100.39	(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)	110.43	106.42	102.40	98.39	94.37	90.35	90.35	94.37	98.39	102.40	106.42	110.43	
∑(44)1...12 =												1204.73	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	163.77	143.23	147.80	128.86	123.64	106.70	98.87	113.45	114.81	133.80	146.05	158.60	
∑(45)1...12 =												1579.59	(45)
Distribution loss 0.15 x (45)m	24.57	21.49	22.17	19.33	18.55	16.00	14.83	17.02	17.22	20.07	21.91	23.79	(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel	150.00	(47)
Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.39	(48)
Temperature factor from Table 2b	0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.75	(50)
Enter (50) or (54) in (55)	0.75	(55)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Water storage loss calculated for each month (55) x (41)m	23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

23.33	21.07	23.33	22.58	23.33	22.58	23.33	23.33	22.58	23.33	22.58	23.33	(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

210.36	185.32	194.40	173.95	170.24	151.79	145.46	160.05	159.90	180.39	191.14	205.20	(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

210.36	185.32	194.40	173.95	170.24	151.79	145.46	160.05	159.90	180.39	191.14	205.20

∑(64)1...12 = 2128.21 (64)

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

91.73	81.29	86.42	78.92	78.39	71.55	70.15	75.00	74.25	81.76	84.64	90.01	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	139.36	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	23.66	21.01	17.09	12.94	9.67	8.16	8.82	11.47	15.39	19.54	22.81	24.32	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	265.38	268.13	261.19	246.42	227.77	210.24	198.53	195.78	202.72	217.49	236.14	253.67	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	36.94	(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)	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	-111.48	(71)
Water heating gains (Table 5)	123.29	120.97	116.16	109.61	105.36	99.37	94.29	100.81	103.12	109.90	117.55	120.98	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	480.14	477.92	462.25	436.77	410.61	385.59	369.45	375.86	389.04	414.74	444.31	466.77	(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	
South	0.77	x	13.06	x	46.75	x 0.9 x	0.63	x	0.70	=	186.60	(78)
East	0.77	x	1.22	x	19.64	x 0.9 x	0.63	x	0.70	=	7.32	(76)
West	0.77	x	10.16	x	19.64	x 0.9 x	0.63	x	0.70	=	60.98	(80)

Solar gains in watts ∑(74)m...(82)m

254.91	439.23	609.34	760.92	851.81	843.87	814.43	747.94	662.59	488.18	306.36	217.41	(83)

Total gains - internal and solar (73)m + (83)m

735.04	917.15	1071.59	1197.69	1262.42	1229.45	1183.88	1123.80	1051.63	902.92	750.66	684.19	(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	0.97	0.91	0.80	0.62	0.46	0.50	0.74	0.94	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.75	19.97	20.27	20.61	20.85	20.97	20.99	20.99	20.92	20.59	20.10	19.71	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	19.90	19.90	19.91	19.92	19.92	19.93	19.93	19.93	19.93	19.92	19.92	19.91	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.99	0.96	0.89	0.74	0.53	0.35	0.39	0.66	0.92	0.99	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	18.25	18.58	19.01	19.48	19.78	19.91	19.93	19.93	19.87	19.47	18.77	18.20	(90)

Living area fraction — Living area ÷ (4) = 0.21 (91)

Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	18.57	18.87	19.28	19.72	20.01	20.13	20.15	20.15	20.09	19.70	19.05	18.52	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	18.57	18.87	19.28	19.72	20.01	20.13	20.15	20.15	20.09	19.70	19.05	18.52	(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	0.88	0.75	0.55	0.37	0.42	0.67	0.91	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	729.62	899.18	1019.60	1055.35	943.21	675.58	443.75	466.40	706.10	824.97	738.08	680.49	(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]	1845.68	1803.06	1644.53	1376.02	1054.23	694.64	446.08	470.22	755.40	1155.10	1522.95	1833.92	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	830.35	607.41	464.95	230.89	82.60	0.00	0.00	0.00	0.00	245.62	565.10	858.15	

∑(98)1...5, 10...12 = 3885.08 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 36.72 (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 (%)		93.50	(206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	888.08	649.64	497.27	246.94	88.34	0.00	0.00	0.00	0.00	262.70	604.39	917.81

∑(211)1...5, 10...12 = 4155.16 (211)

Water heating

Efficiency of water heater	88.11	87.75	87.06	85.57	83.01	79.80	79.80	79.80	79.80	85.64	87.53	88.22	(217)
Water heating fuel, kWh/month	238.75	211.19	223.30	203.29	205.09	190.21	182.29	200.56	200.38	210.65	218.37	232.60	

∑(219a)1...12 =	2516.67	(219)

Annual totals

Space heating fuel - main system 1		4155.16	
Water heating fuel		2516.67	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
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		75.00	(231)
Electricity for lighting (Appendix L)		417.82	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	7164.65	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4155.16	x	3.48	x 0.01 =	144.60	(240)
Water heating	2516.67	x	3.48	x 0.01 =	87.58	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	417.82	x	13.19	x 0.01 =	55.11	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	417.18	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.16	(257)
SAP value	83.79	
SAP rating (section 13)	84	(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	4155.16	x	0.216	=	897.51	(261)
Water heating	2516.67	x	0.216	=	543.60	(264)
Space and water heating				(261) + (262) + (263) + (264) =	1441.11	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	417.82	x	0.519	=	216.85	(268)
Total CO_2, kg/year				(265)...(271) =	1696.89	(272)
Dwelling CO_2 emission rate				(272) ÷ (4) =	23.53	(273)
EI value					84.92	
EI rating (section 14)					85	(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	4155.16	x	1.22	=	5069.30	(261)
Water heating	2516.67	x	1.22	=	3070.33	(264)
Space and water heating				(261) + (262) + (263) + (264) =	8139.63	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	417.82	x	3.07	=	1282.70	(268)

Primary energy kWh/year	9652.58	(272)
Dwelling primary energy rate kWh/m2/year	91.23	(273)