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Energy Statement

Berkeley Homes (Oxford & Chiltern) Ltd.

Vastern Road, Reading

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Date: December 2020

DOCUMENT CONTROL RECORD

REPORT STATUS: FINAL

Version	Date	Reason for issue	Author	Checked by	Approved for Issue by
v.1	06.11.20	Draft	N. Doshi	J. Peck	J. Peck
v.2	09.12.20	Final	N. Doshi	J. Peck	J. Peck
v.3	10.12.20	Final minor comments	N. Doshi	J. Peck	J. Peck

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Executive Summary

The overriding objective in the formulation of the energy strategy for Vastern Road is to maximise the reduction in development CO₂ emissions through the application of a series of measures which are cost-effective, viable and technically appropriate. Berkeley Homes (referred to henceforth as 'The Applicant') recognise the need to prioritise an energy strategy which takes into account a number of considerations, including user-friendliness of systems for residents, operational costs, and the reliability of adopted measures.

The proposed energy strategy for Vastern Road will therefore provide the following:

- > High standards of fabric efficiency, going significantly beyond the requirements of Part L 2013. This includes low air permeability rates and targeted thermal bridges;
- > MVHR systems where required, providing heat recovery & cooling whilst contributing further to the overall CO₂ reduction of the development;
- > Provision of a low carbon site heat network, future-proofed for a potential connection to a wider Reading area network;
- > Efficient & simple systems for residents to use;
- > High levels of control for resident comfort;
- > Application of PV panels to all suitable roof areas, providing generating potential for the overall development.

The development proposes to supply its heat from an Air Source Heat Pump (ASHP)-led site heat network, which utilises low carbon electricity. This delivers significant CO₂ savings to the development when assessing against the more accurate SAP 10.1 CO₂ emissions factors, with CO₂ continuing to decrease for the lifetime of the development as the electricity grid decarbonises further.

The proposed energy strategy seeks to prioritise measures which first and foremost reduce energy demand, before assessing means of energy supply and alternative generation sources. This is considered a best practice approach. However, the scheme will also incorporate low and zero carbon technologies to further reduce site wide CO₂ emissions as well as providing a source of on-site electricity generation.

Expected energy demands have been tested against the forward-looking SAP 10.1 methodology which more accurately reflects the decarbonisation of the electricity grid. CO₂ savings will therefore be delivered in the long-term through a future-proofed energy strategy, as set out in the table below.

In summary, the development is expected to achieve a **36.6%** reduction in Regulated CO₂ emissions. This goes beyond the requirements of the new RBC Local Plan for on-site reductions. For clarity, the strategy still

enables compliance with Part L 2013 of Building Regulations when assessed under SAP 2012 emission factors.

The Applicant also acknowledges the requirements of Policy H5c, which seeks for the use of offsetting measures in order for the development to achieve a status of Zero Carbon once on-site measures have been accounted for. This results in a calculated offsetting fee of £228,420.

Regulated Carbon dioxide emissions (kg CO ₂ per annum)	
	SAP 10.1 Emission Factors
Baseline	200,200
After <i>Energy Efficiency Measures</i>	133,100
After <i>Renewable Measures</i>	126,900
Total % Savings (On-site)	36.6%

CONTENTS

Executive Summary	2
1. INTRODUCTION	5
2. DEVELOPMENT OVERVIEW & PLANNING	6
3. ENERGY STRATEGY METHODOLOGY	9
Baseline Emissions Assessment	10
Report Methodology	11
4. ENERGY EFFICIENCY MEASURES – DEMAND REDUCTION	11
Residential - Fabric Energy Efficiency	15
5. HEATING STRATEGY	15
Centralised Area Wide Heat Network	16
Decentralised Heat Network	16
Proposed Heating Strategy	21
6. RENEWABLE ENERGY TECHNOLOGIES	24
7. ZERO CARBON – POLICY H5C	25
8. SUMMARY	25
APPENDICES	27

1. INTRODUCTION

- 1.1** This document has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, on behalf of Berkeley Homes (Oxford & Chiltern) Ltd in support of the development proposed for the Vastern Road site in Reading.
- 1.2** The formulation of the energy strategy follows an energy hierarchy which prioritises a reduction in energy demands before considering how to optimise the carbon intensity of the energy supply. Key considerations include:
- > To achieve the maximum reduction in carbon dioxide (CO₂) emissions by considering future trends for energy supply and generation as well as current ones;
 - > To determine an energy strategy which is deliverable, technically appropriate and which does not result in unreasonable running costs for occupants;
 - > The provision of high-quality low energy buildings that are adapted to future changes in climate;
 - > To minimise, to the lowest possible extent, emissions of pollutants such as oxides of nitrogen (NO_x) and particulate matter, thereby minimising the effects on local air quality.

2. DEVELOPMENT OVERVIEW & PLANNING

Site Location

- 2.1 The Vastern Road development is located in the centre of Reading, 0.3km north from the rail station and just south of the River Thames.

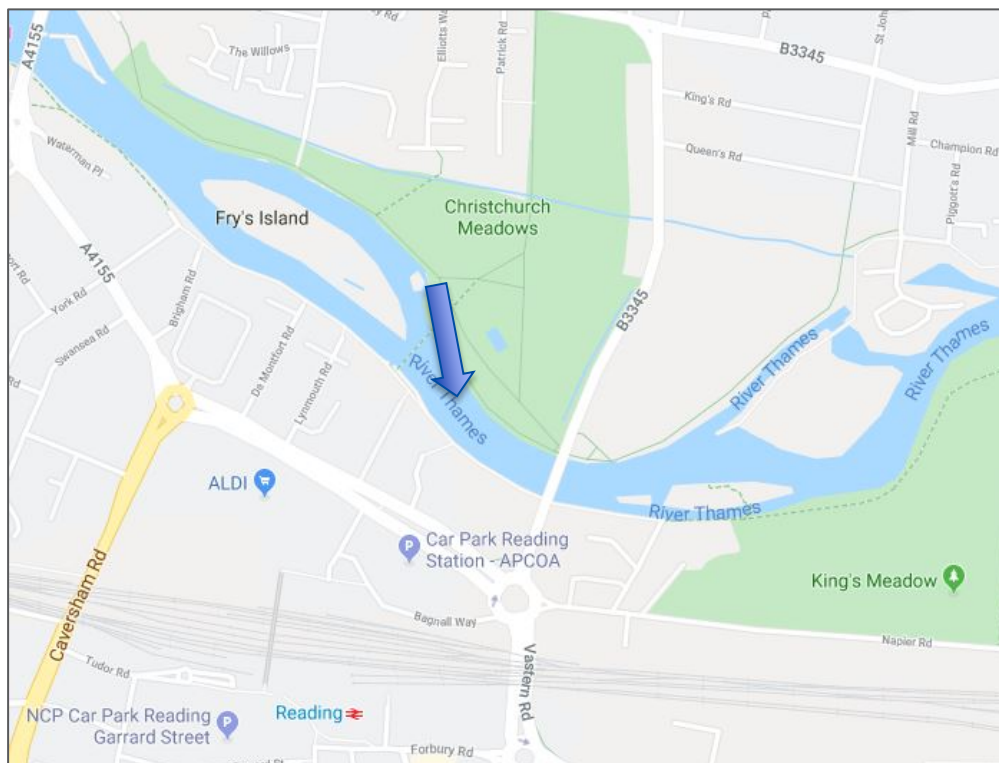


Figure 1: Site Location (Source: Imagery @ 2019 Google, Map data ©2019 Google)

Development Proposals

- 2.2 Consent is sought for the development of the site to deliver 209 new dwellings.

National Planning Policy

- 2.3 The revised National Planning Policy Framework (NPPF) was published on the 19th February 2019 and sets out the Government's planning policies for England.
- 2.4 The NPPF provides a framework for achieving sustainable development, which has been summarised as "*meeting the needs of the present without compromising the ability of future*

generations to meet their own needs" (Resolution 42/187 of the United National General Assembly).
At the heart of the framework is a **presumption in favour of sustainable development**.

- 2.5 The document states that the planning system has three overarching objectives which are interdependent and need to be pursued in mutually supportive ways:
- a) **An economic objective** – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;
 - b) **A social objective** – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and
 - c) **An environmental objective** – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

Reading Local Plan

- 2.6 The new RBC Local Plan was adopted on November 4th 2019. The following two policies are considered most pertinent to this application.

- 2.7 Policy H5c states:

‘All major new-build residential development should be designed to achieve zero carbon homes’.

Zero Carbon is described, in paragraph 4.4.46 of the Local Plan, as being a minimum of a 35% improvement over the 2013 Building Regulations plus a contribution of £1,800 per tonne towards carbon offsetting within Reading.

- 2.8 Policy CC4 states:

‘Any development of more than 20 dwellings... shall consider the inclusion of decentralised energy provision, within the site, unless it can be demonstrated that the scheme is not suitable, feasible or viable for this form of energy provision.

Where there is existing decentralised energy provision present within the vicinity of an application site, further developments of 10 dwellings... will be expected to link into the existing decentralised energy network or demonstrate why this is not feasible.’

- 2.9** The Local Plan promotes decentralised energy including CHP and district heating. It does however go onto explain, as reviewed in this report, that strategy which emphasises the role of energy efficiency measures and links the CO₂ performance of the site to the decarbonisation of the electricity grid will lock in substantial CO₂ savings for the lifetime of the development. In this way the ambitions of policy H5c can be most closely realised.
- 2.10** Sustainable Design and Construction SPD highlights that combustion-based CHP should be avoided and that there is a preference for ground-source heat pumps over air-source heat pumps.
- 2.11** The SPD goes on to explain that If GSHP systems are discounted then technical analysis at the detailed planning application stage should be provided outlining the constraints.
- 2.12** Where developments are located in high priority areas, such as the proposed development, for district heating (as identified by the SPD) and where there is no existing network to connect to, the following provisions should be made:
- > Designing the development with wet space heating and hot water distribution systems, so that the building heat distribution network can interact with a DH network;
 - > Space provision in heating plant rooms for connection to a DH network;
 - > Where necessary, provide buried and capped-off DH pipework from the development's plant room to a convenient location in preparation for connection to a DH network.

Berkeley Homes Commitments

- 2.13** From May 2018, Berkeley Homes committed to produce a transition plan for each development which enables the homes to operate at net zero carbon by 2030. To meet this commitment Berkeley Homes have undertaken a full year of research to inform this approach.
- 2.14** The long-term trajectory is considered most appropriate due to changing nature of the carbon intensity of energy supply, as outlined in Section 3 of this report.

3. ENERGY STRATEGY METHODOLOGY

- 3.1 The approach taken for the development of this energy strategy is to reflect current reality and future projections for CO₂ emissions. In so doing, the CO₂ reductions shown can be expected to continue through the lifespan of the development.
- 3.2 The CO₂ emission factors in current Part L (2013) & SAP 2012 are outdated. This is shown in Figure 2, below.

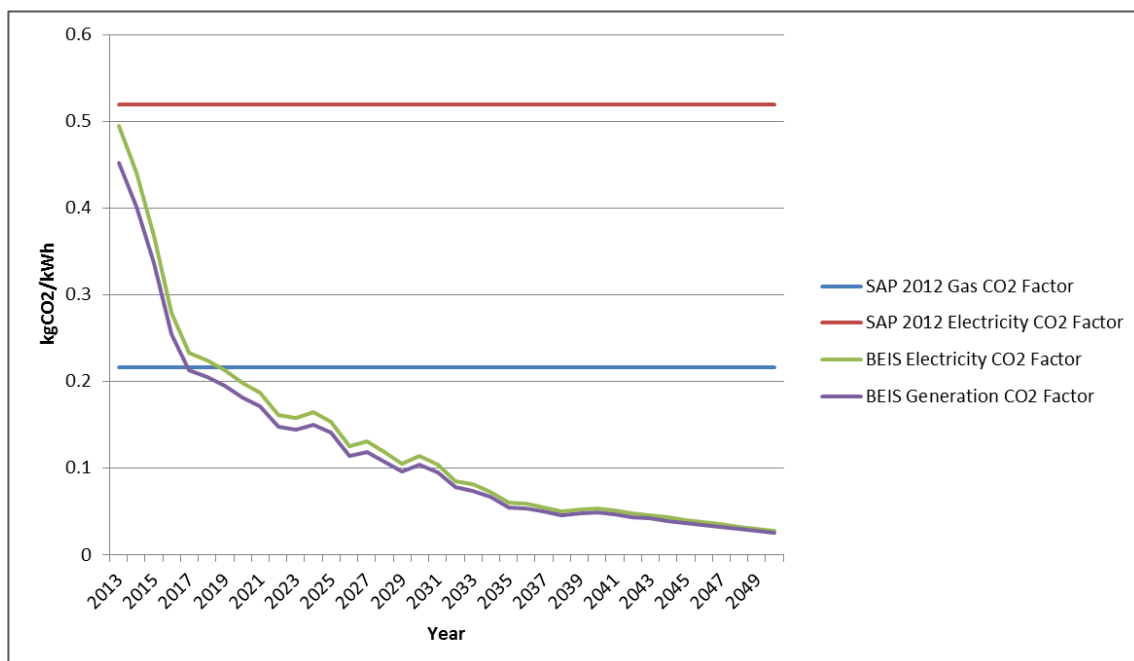


Figure 2: SAP 2012 and BEIS Projected Emission Factors (2013 – 2050)

- 3.3 SAP 2012 & Part L 2013 therefore fail to take account of current actual CO₂ emission factors. The actual electricity CO₂ emission factor has declined substantially since 2012 due to the increased amount of renewable electricity generation and declining use of coal-fired generation.
- 3.4 The Future Homes Standard document, the basis for new versions of Part L and Part F of the Building Regulations, has concluded its consultation. As part of this SAP 10.1 revised emission factors have been published. It is expected that a new version of Part L will be formally adopted in 2021. By this point the SAP 2012 emission factors will be nine years out of date. Unrealistic emission factors could lead to inappropriate energy strategies which are not future proofed. For example:
- > Gas CHP strategies, typically the baseline energy strategy for sites of the size and density of Vastern Road, would not pass the minimum requirements of Part L of the Building Regulations

when using the SAP10.1 emission factors. This is because gas CHP engines will increase rather than decrease CO₂ emissions under proposed emission factors.

- 3.5** Alternative approaches are therefore desirable in determining the most appropriate energy strategy for a development in the context of the aims set out in the introduction.
- 3.6** SAP10.1 has been developed by BRE and is intended for use with the next update of Part L. The BRE SAP 10.1 manual states that ‘the emission factors and primary energy factors for electricity are a 5-year projection for 2020-2025’, so the trajectory towards them is ongoing and with a clear evidence base and policy platform.
- 3.7** The proposed changes to these are summarised in Table 1.

	SAP 2012	SAP 10.1	Change
Gas Emission factor (kg CO₂/kWh)	0.216	0.210	3% reduction
Electricity Emission factor (kg CO₂/kWh)	0.519	0.136	74% reduction

Table 1: SAP 10.1 summary of emission factor changes

- 3.8** It is important to note that at present any assessment would be required to use SAP 2012 and therefore compliance with Part L 2013 should still be achieved. Any site-based CO₂ emissions would have to be converted using SAP 10.1 figures to identify the equivalent site wide emissions under the proposed methodology.

Assessment Methodology

- 3.9** Due to the above, we have concluded that it is most appropriate to utilise SAP10.1 emission factors in the development of this energy strategy.

Baseline Emissions Assessment

- 3.10** Table 2 shows the Regulated baseline CO₂ emissions for the development. As outlined above, emissions have been calculated against the SAP 10.1 emission factors as these are considered more appropriate.

Table 2: Regulated Baseline Case – SAP 10.1 Emission Factors	
	Regulated CO₂ (kg/year)
Development Baseline	200,200

Report Methodology

- 3.11** Following the establishment of a CO₂ baseline to assess against, the report will now follow a 'fabric first' approach in order to prioritise measures which reduce energy demand before assessing energy supply and generation measures.
- 3.12** The estimated annual energy demand has been calculated using Standard Assessment Procedure (SAP 2012) methodology, with energy (kWh/yr) outputs from the TER and DER worksheets used to apply the SAP10.1 emission factors. SAP calculates the Regulated energy demands associated with hot water, space heating and fixed electrical items.
- 3.13** Calculations have been performed on representative dwelling types. These encompass ground, mid, and top floor flats, as well as taking into account differences in orientation and the impact of exposed floors and terraces. The selected dwellings therefore represent a fair aggregation of the proposed unit mix.

4. ENERGY EFFICIENCY MEASURES – DEMAND REDUCTION

- 4.1** In line with a fabric first approach which seeks to minimise energy demand, the following energy efficiency measures are proposed for all dwellings.

Insulation Standards

- 4.2** The residential units will incorporate enhanced insulation in the building envelope (walls, roofs, floors, and glazing) to achieve average U-Values over and above those required by Part L (2013) Building Regulations. These are likely to include:
- > Glazing with a U-value of 1.40 W/m².K;
 - > External wall U-value of 0.17 W/m².K;
 - > Party walls will be fully insulated and sealed (achieving an effective U-Value of 0.00 W/m².K);
 - > Corridor wall with a U-value of 0.17 W/m².K;
 - > Exposed upper floor U-values (over plant rooms, car parks, and commercial areas) of 0.15 W/m².K;
 - > Ground floor U-values of 0.10 W/m².K;
 - > Main roof U-value with a U-value of 0.11 W/m².K;

> Terrace roof U-value of 0.15 W/m².K.

Air Tightness & Ventilation

- 4.3** Air tightness standards will conform to, and exceed, Approved Document Part L requirements. By reducing air leakage loss and convective bypass of insulation, an improvement of design air permeability rate from 10m³/h.m² to 4m³/h.m² or less will further reduce space heating requirements.
- 4.4** It is proposed to install Parts L & F compliant (System 4) Mechanical Ventilation with Heat Recovery (MVHR) where required. An assumption of 50% of all dwellings with these systems has been made in the calculations for this report.
- 4.5** These systems will remove stale air and odours from kitchens and wet rooms. The selected systems will prioritise efficiency and performance to contribute towards the overall CO₂ emissions reduction for the development by reducing space heating demands, as well as facilitating internal cooling without the use of additional mechanical cooling measures.
- 4.6** The selected MVHR units will have heat recovery efficiencies of 91% and a Specific Fan Power (SFP) targeted as follows:
- > ≤ 0.42 SFP for units with 2 wet rooms (1 bathroom);
 - > ≤ 0.50 SFP for units with 3 wet rooms (2 bathrooms).
- 4.7** It is proposed to utilise centralised Mechanical Extract Ventilation (cMEV – System 3) for the remaining dwellings. The selected MEV units will have a maximum specific fan power (sfp) of 0.16 W/l/s.

Thermal Bridging

- 4.8** In well insulated buildings, as much as 30% of heat loss can occur through thermal bridges. This occurs when highly conductive elements (e.g. metal studs) in the wall construction enable a low resistance escape route for heat.
- 4.9** As energy efficiency standards improve, an increased importance is being placed on addressing heat losses through thermal bridging. Figure 3 illustrates the benefits of reducing thermal bridges.

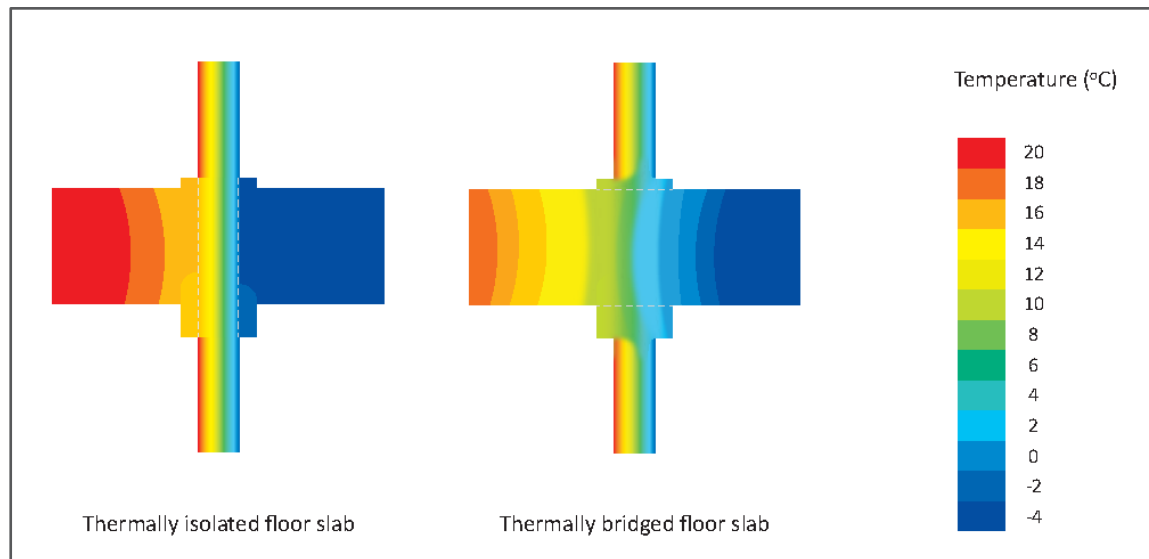


Figure 3: Thermal Bridging

- 4.10** The Applicant is likely to undertake detailed modelling of all major junctions. The results of initial assessments will be used to inform the design process and further modelling will continue to take place until the required performance targets are met. It should be noted that this bespoke approach to junction design goes significantly beyond the process followed for most developments, thus achieving an improved energy performance.
- 4.11** It is also considered that a specification which actively seeks to design out poor junction performance demonstrates a more balanced approach than only the use of very low U-values which have been specified to mitigate a lack of junction modelling. The specification for the proposed Vastern Road development places significant emphasis on both design aspects.
- 4.12** The following psi values have been used in the initial modelling and will be targeted during the detailed design:
- > Ground Floors - 0.16 W/m.K;
 - > Exposed Floors (over car parks, plant rooms, commercial areas)– 0.20 W/m.K;
 - > Intermediate Floor – 0.07 W/m.K;
 - > Balcony junction to wall – 0.15 W/m.K;
 - > Flat roof – 0.04 W/m.K;
 - > Flat roof with parapet – 0.30 W/m.K;
 - > Party Roof – 0.04 W/m.K;

> Corner (normal) – 0.09 W/m.K;

- 4.13** Further details will be determined during the detailed design stage when further bespoke calculations are undertaken on the targeted junctions.
- 4.14** Values equivalent to the Accredited Construction Details (ACDs) have also been used for the Lintels (0.30 W/m.K), Sills (0.04 W/m.K), and Jambs (0.05 W/m.K) of the windows. It is not considered appropriate to target higher performance standards than this at this point due to the impact that the choice of glazing manufacturer may have on the detailing.

Space Heating & Hot Water

- 4.15** The space heating requirement of the proposed Vastern Road development will be reduced by the fabric, air tightness and ventilation measures detailed above.
- 4.16** Further details regarding the proposed heating strategy are explored in Section 5 of this report. For the purposes of demonstrating the energy efficiency of this development, and in alignment with policy a gas boiler has been considered for the baseline in comparison to the notional Part L building.

Limiting the Risk of Summer Overheating

- 4.17** Minimising the risk of summer overheating is important so as to ensure that homes are adapted to climate change and remain comfortable to occupy in the future.
- 4.18** The key measures identified in order to mitigate overheating risk are as follows:
- > Shading is provided to the largest windows from the presence of balconies. The balconies will provide solar shading during the summer months when the sun is high in the sky, but allow the beneficial winter solar gains when the sun is lower in the sky;
 - > Solar control glazing (low g-value) will be installed to reduce uncomfortable solar heat gains across the development. A g-value of 0.45 has been used in the compilation of this energy strategy;
 - > All homes will have openable windows and therefore have the ability to naturally ventilate.
- 4.19** The overheating strategy does not utilise active cooling measures. This ensures an additional energy demand is not added to the development to facilitate cooling.

Lighting & Appliances

- 4.20** Energy efficient lighting will be installed in 100% of internal fittings in the homes.

- 4.21** It is very difficult to design and construct homes to reduce the unregulated electricity demands, because this is almost entirely dependent on the occupant of a home and can vary substantially. However, the Applicant is committed to ensuring that all efforts are made to enable the residents to minimise their unregulated electricity consumption.

Residential - Fabric Energy Efficiency

- 4.22** Table 3 demonstrates that by applying the measures outlined in this section, the development is thermally efficient. Further it exceeds the Target Fabric Energy Efficiency (TFEE) requirements of Building Regulations Part L1A (2013).

Residential - Example Unit Type	Unit Area (m ²)	No. Units	TFEE (kWh/m ² /yr)	DFEE (kWh/m ² /yr)
2 Bed Mid-Floor (NW facing)	71	27	42.1	37.7
1 Bed Mid-Floor (SE facing)	50	47	34.3	34.1
2 Bed Mid-Floor (NW facing)	71	42	42.1	37.7
2 Bed Top-Floor (SW facing)	63	35	59.6	48.1
2 Bed Ground-Floor (NE/NW facing)	63	25	65.8	53.8
2 Bed Exposed-Floor (SE facing)	66	18	52.3	45.7
1 Bed Terraced (SW/NW facing)	51	15	61.8	49.1
Area Weighted Average			48.7	42.2
Reduction Achieved (Area Weighted)			13.2%	

Table 3: TFEE/DFEE results for sample dwelling types

5. HEATING STRATEGY

- 5.1** When considering the long-term CO₂ performance of the energy strategy for this development, the options for the supply of heat to the site can be summarised as the following hierarchy in order of the priority described by policy:
- > Centralised area wide heat network in Reading;
 - > Decentralised heating network which is led by low carbon plant;
 - > A system in each flat, which given discussion on CO₂ performance would be powered by electricity.
- 5.2** Using Combined Heat and Power (CHP) plant as a heat source for a heat network is not preferred by policy (as stated within the SPD) and will increase the development CO₂ emissions against the CO₂ baseline. As a result, it is not considered further.

Centralised Area Wide Heat Network

- 5.3** The connection of the development to an area-wide heat network in central Reading would provide a resilient supply of low carbon heat. However, having engaged with Reading Borough Council it is clear that there are no existing or imminently planned networks for connection.
- 5.4** Whilst ambitions to move toward this direction may be present, the absence of clear plans detailing when or where such a network may be delivered renders the carbon and cost risk that the Vastern Road development will remain with a temporary site only heating strategy for a very long period high.
- 5.5** Although there is no area network present, the development is to be provided with a site heat network which will be future proofed to ensure a connection can be made at a later date should a wider area network come forward.

Decentralised Heat Network

- 5.6** Given a connection to a centralised area wide heat network is not currently possible, a decentralised heat network for the development has been considered. The following describes how various heating technologies were reviewed with respect to technical appropriateness and heat cost to residents.
- 5.7** The preferred option will be one that:
- > Can guarantee heat;
 - > Estimates the lowest heat cost to the resident.
 - > Demonstrates carbon savings over the energy efficient case;
- 5.8** All the options will produce heat that will feed a heat network that will pipe hot water to heat interface units (HIU) at each dwelling. This pipework will be expected to be designed and installed in line with industry standards namely CIBSE CP1: Heat Network Code of Practice for the UK. If this is employed the heat loss from the heat network would be limited. For the purposes of the SAP assessment a heat loss factor of 1.5 has been used. This accounts for heat losses of circa 33% from the heat network.
- 5.9** Heat pumps used in conjunction with a heat network ensures centralised production of heat that can be distributed to many dwellings. In this configuration this nascent use of heat pumps can be an energy efficient method of producing heat.

5.10 An initial assessment has ascertained that should a heat pump led heating strategy be proposed it would require, subject to review at detail design:

- > 365 kW heat pumps;
- > 8,000 l thermal storage.

5.11 There are several natural resources around the development that could be used for a heat pump including ground, water, and air. All of which are considered below.

Closed-Loop GSHP

5.12 A closed loop Ground Source Heat Pump (GSHP) uses the typically stable properties of the ground to exchange heat with refrigerant inside a preinstalled pipe. Given the temperature in the ground is relatively stable.

5.13 Appropriateness of this technology is based on ability to install the ground loops, which can be vertical or horizontal. The development can afford 1,939 m² for the bore hole works required for this system. This area is insufficient to generate the required heat.

5.14 Further, beyond the technical considerations noted above the development is on a brownfield site further complicating any potential implementation.

5.15 Based on above a closed loop GSHP system is inappropriate for this development.

Open-Loop GSHP

5.16 An open loop GSHP abstracts water from ground aquifers with the utilisation of a submersible pump. The process requires two wells one for injection and another for extraction. Like vertical loops the boreholes for an open loop system are typically just as deep to access the water source.

5.17 A review of the British Geological Survey, Figure 4, demonstrates that there are not records of boreholes in the vicinity of the development greater than 30 m. Therefore, it is not possible to confirm an open loop GSHP would be capable of generating sufficient heat demand.

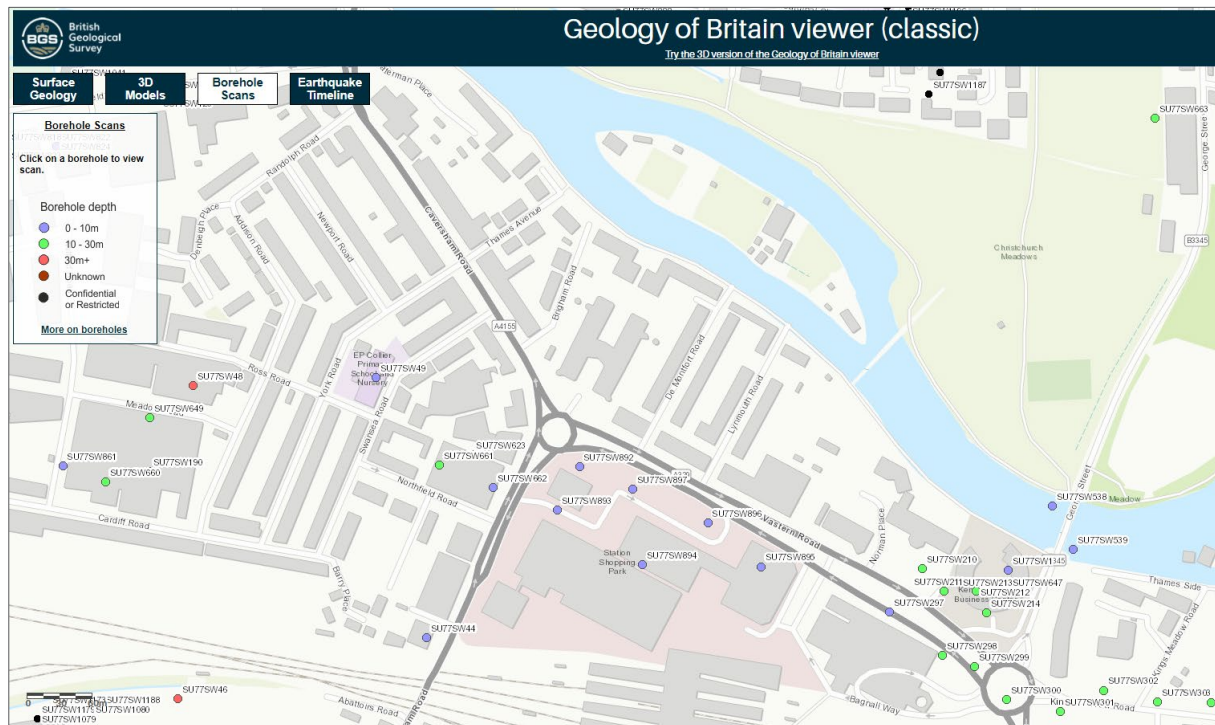


Figure 4: Bore Hole Data (<https://mapapps.bgs.ac.uk/geologyofbritain/home.html>)

- 5.18** As highlighted earlier, given the development is on a brownfield site abstracting water from an aquifer through potentially contaminated strata of land for reinjection back into the water table may be unacceptable. This information can only be gained following investigative bore hole testing. This adds further costs to the project and could potentially delay delivery. These tests could further yield insufficient heat availability, introducing a heat security risk.
- 5.19** As this technology could, only after regulatory scrutiny by the Environment Agency, deliver some of the heat load, it has been reviewed against the other technically acceptable options for their impact on heat costs, though the technical concerns are significant.

Surface WSHP

- 5.20** Surface water source heat pumps operate on similar principles to open loop ground source, but extract water from surface water bodies. Water temperatures follow a dampened profile of external air temperatures not getting as hot or as cold as air. This means that the technology is less efficient than GSHP but better than Air Source Heat Pumps (ASHP).
- 5.21** For the proposed development, the River Thames is the most likely heat source. This, like the open loop GSHP would require complying with several regulatory requirements laid down by the Environment Agency, which could ultimately prevent heat provision to the development.

- 5.22** Further to this, the plant required to collect the water from the Thames would be required to be as close as possible to the water source. This would place the plant outside the redline of this development.
- 5.23** Similar to the open loop GSHP, as this technology could, following extensive assessment and licencing, deliver some of the heat load, it has been reviewed against the other technically acceptable options for their impact on heat costs.

ASHP

- 5.24** Air source heat pumps (ASHP) generate heat via compression of a refrigerant which has extracted ambient heat from the external air. The compressive action raises the temperature of the refrigerant and allows it to provide heating. It would be expected that this plant would have a Seasonal Coefficient of Performance (SCOP) of 2.80 for application on a heat network.
- 5.25** ASHP provide greater flexibility as they can be installed within the development boundaries and on roof spaces. This presents a technology that is most likely to be applicable to this development.
- 5.26** The limitation for this technology is the ambient air temperature, as the external temperature reduces the ability to extract heat also reduces. This is also the case with respect to its efficiency. This does mean that in colder months, the energy required to generate heating will increase.
- 5.27** Current ASHP technology operates best when they are required to output small increases to the flow temperature. The technology is therefore strained if required to consider peak loads, to help with this thermal storage has been provided but does not remove the problem entirely.
- 5.28** To deliver the entire heating load the required capacity of the ASHP plant would be greater than the calculated load discussed earlier.
- 5.29** As a result, it would be advantageous to mitigate heat supply risks by installing boiler generation. The gas boilers are expected to only operate during peak conditions, providing one third of the annual heat requirements. This limits the stress placed on any heat pump option which would provide two thirds of the annual heat generation. Further, given gas prices are significantly lower than electric the heat costs would also be reduced.
- 5.30** Any gas boilers utilised for this scheme would be low NO_x and condensing. It would be expected that they would have minimal to no impact on the local air quality given they would operate for a relatively shorter period of time

Heat costs

- 5.31** Resident heat costs are made of two components, a fixed and a variable charge. The variable charge is directly related to the efficiency of heating plant and the cost of fuel. The fixed charge is made up of several elements that ensures ongoing provision of heat, be that billing, proactive maintenance,

or plant replacement. In simple terms the costlier and more complex the plant the greater the fixed charge. The fixed charges are expected to be spread fairly between the heat users. This development will have a relatively low number of heat customers so is unlikely to benefit from the economies of scale afforded to typical heat networks, therefore increasing the associated fixed charges that are required to be paid.

- 5.32** Figure 5 shows the estimated annual heat costs for each of the heat pump only options above and then the lowest cost option of these with boilers. As the figure demonstrates the GSHP and WSHP options are costlier than an ASHP option. Further details of the cost breakdown can be found in Appendix D.
- 5.33** Heat pump technologies are relatively new to the UK when used in a heat network. In fact, there are relatively few case studies that can demonstrate effective and efficient use of 100% heat pump operation. This poses a heat security risk that must be addressed.
- 5.34** Further given heat pump technologies rely on changing environmental conditions, there are risks that there will be cost spikes as a result of reduced plant efficiency.
- 5.35** As a result, it is recommended that heat pump solutions are supplemented with gas boilers. Further, they do help to marginally reduce the overall annual heat costs.

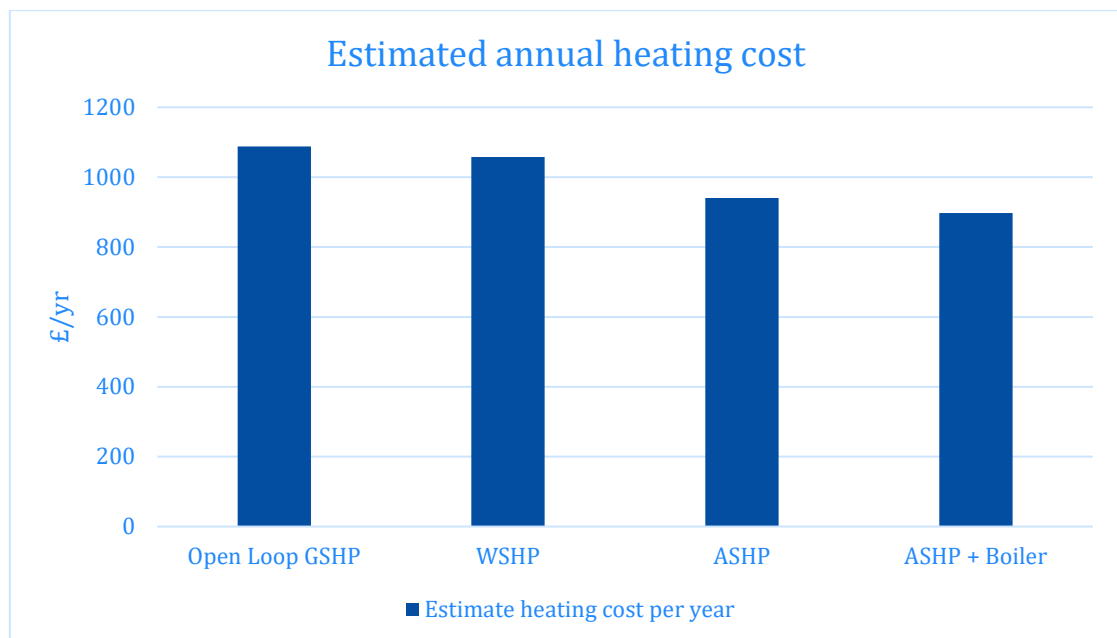


Figure 5: Estimated annual heat costs

Proposed Heating Strategy

- 5.36** As discussed earlier, there are 3 challenges that must be met to ensure the proposed heating strategy is appropriate.
- 5.37** It has been demonstrated that:
- > Heat can only be reliably generated when heat pumps are supplemented with gas boilers;
 - > The type of heat pump system with the lowest resident heat cost would be ASHP.
- 5.38** Further to above the technical uncertainty and increased resident heat costs applicable to the GSHP and WSHP solutions means that they are not considered further.
- 5.39** Following an iterative process to maximise low carbon heat while reducing resident heat costs, Table 4 describes the proposed heating plant characteristics that an ASHP and boiler heating strategy could adopt.
- 5.40** This strategy has been thoroughly investigated spatially and technically, with the development's energy centre described in Figure 6 and required roof plant in Figure 7. The energy centre will be the central point for distributing heat thereby housing most of the heat distribution plant and the proposed gas boilers. Components of the ASHP are however required to be placed on the roof, Figure 7, and piped back to an energy centre for distribution to the development.

Heat network information		
Parameter	Heat technology 1	Heat technology 2
Technology	Air Source Heat Pump	Gas fired boilers
Indicative Capacity	365 kW	1.0 MW
Technology heating efficiency	280%	89.5%
Proportion of heat generated for development	67%	33%
Fuel use	Electricity	Natural gas
Thermal stores	Yes	

Table 4: Heating strategy parameters

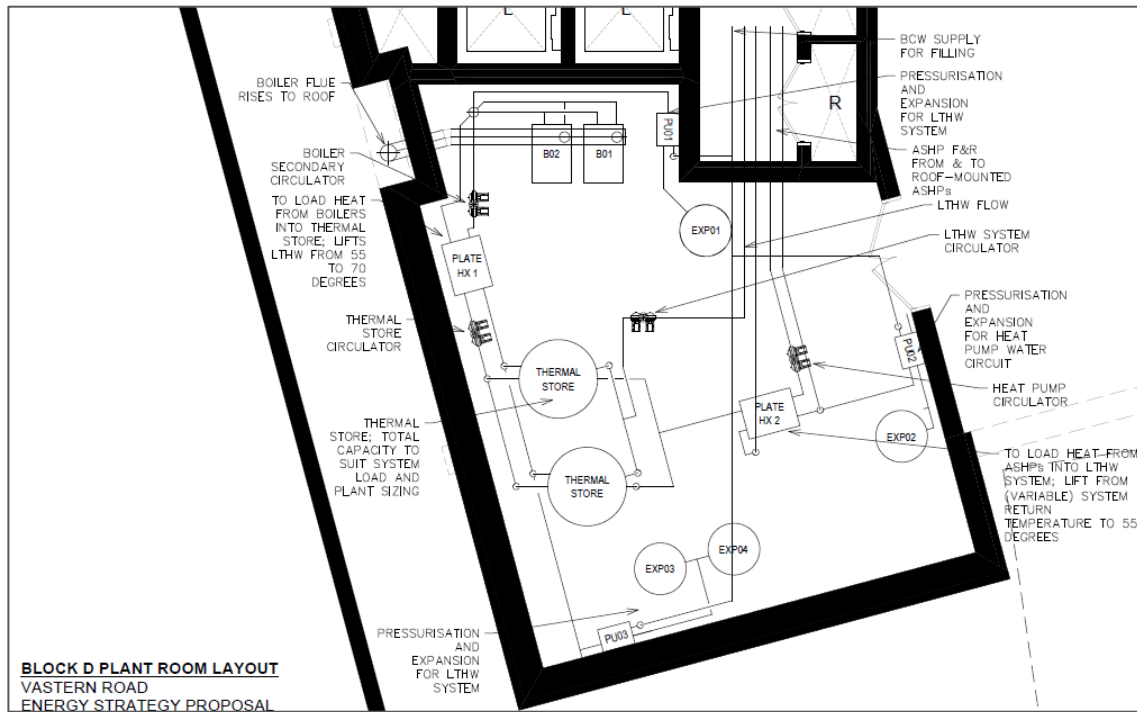


Figure 6: Indicative Energy Centre layout

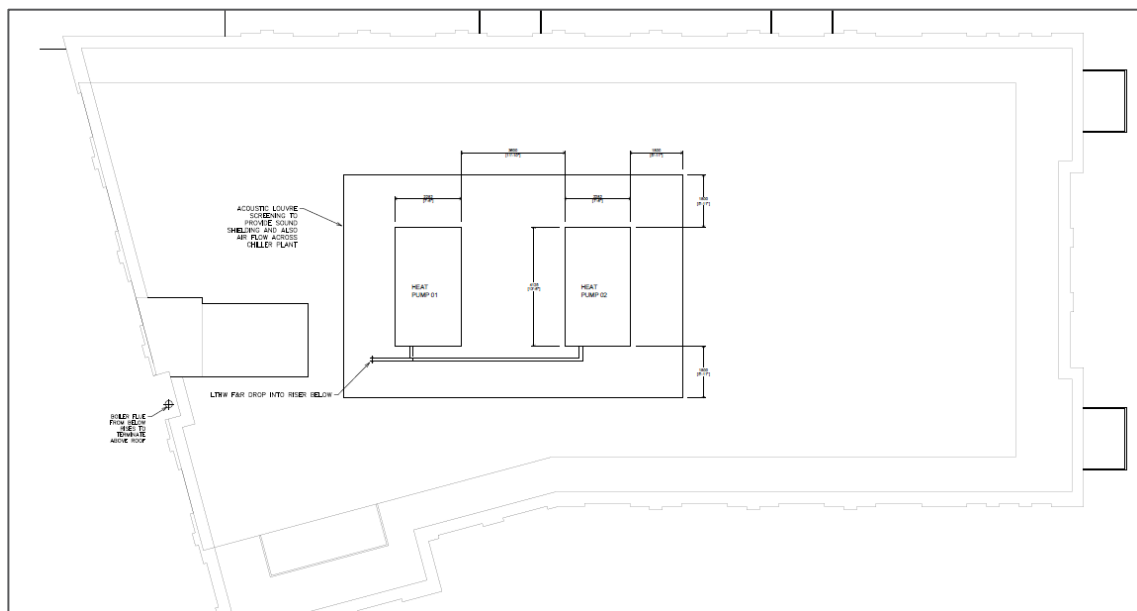


Figure 7: Indicative Roof Plant Layout

- 5.41** It is understood that there is sufficient capacity in the local electricity infrastructure to address the electrical demand that will be required from the ASHP. The site will also benefit from photovoltaic (PV) generation on the most appropriate roof spaces, which could be used to assist in reducing the load on the local electricity network.
- 5.42** It is therefore proposed that the Vastern Road development incorporates ASHP with gas boiler support utilising a site wide heat network. This is to ensure long-term CO₂ reductions, operational reliability, and cost predictability.

Future-proofing

- 5.43** This development is future proofed through the proposed application of a central energy centre and a wet distribution network as it enables future building operators to consider connecting to a wider heat network, should one become available.
- 5.44** Should such a network become available and a decision to connect is taken then the central energy centre could be retrofitted to connect. This work would be centrally located and saves changes for each individual dwelling.
- 5.45** Having both electrical and combustion heating plant provides future use flexibility should there be technological breakthroughs in energy conversion or fuel production.
- 5.46** Table 5 below, details the Regulated CO₂ emissions for the development following application of energy efficiency measures and the proposed heating strategy

Full Development (kg CO ₂ per annum)	
	Regulated Emissions
Baseline	200,200
After <i>Energy Efficiency Measures & heat network</i>	133,100
Total % Savings (On-site)	33.5%

Table 5: Heat Network and Energy Efficiency Reduction CO₂

6. RENEWABLE ENERGY TECHNOLOGIES

- 6.1 As shown in Table 3 and Table 5 an array of energy efficiency measures and a forward-thinking strategy which utilises the ongoing decarbonisation of the electricity network enables the development to achieve a 37% reduction in Regulated CO₂ emissions.
- 6.2 The final part of the energy hierarchy seeks to assess the application of renewable energy technologies to the development.

Photovoltaic (PV) Panels

- 6.3 PV panels are good at enabling substantial reductions in CO₂ emissions. Additionally, as an energy strategy which utilises electricity for space heating and hot water purposes will increase the load on the local electricity grid, it would be beneficial to have a means of reducing this load through an on-site supply. It has therefore been concluded that PV panels represent the most suitable renewable energy technology for the development.
- 6.4 The Applicant is committed to installing PV panels across the most appropriate roof spaces. This takes into account shading restrictions inherent on the lower roof spaces. With panels assigned to the most appropriate areas, it is estimated that ~60 kWp of PV generating capacity can be provided when using a panel output of 320 Wp. Panels are to be positioned at an angle of 5-10 degrees towards a southerly direction. An indicative roof plan has been provided in Appendix E. It should be noted that this has been examined extensively by the Applicant to ensure this figure is realistic.
- 6.5 Table 6 below, details the Regulated CO₂ emissions for the development after the addition 60 kWp of PV panels.

Full Development (kg CO ₂ per annum)	
	Regulated Emissions
Baseline	200,200
After Energy Efficiency Measures	133,100
After Renewable Measures	126,900
Total % Savings (On-site)	36.6%

Table 6: Renewable Reduction CO₂

7. ZERO CARBON – POLICY H5C

- 7.1** The Vastern Road energy strategy has demonstrated a reduction in Regulated CO₂ emissions of 36.6% over the calculated baseline. This exceeds the on-site requirements of Policy H5c, which seeks for a 35% reduction.
- 7.2** In addition to this, Policy H5c also seeks for further offsetting measures to meet a total 100% in Regulated CO₂ emissions in order to achieve a standard of Zero Carbon. As shown in Table 6, a total of 126.9 tonnes of CO₂ is to be offset via this means.
- 7.3** In line with the Reading's Zero Carbon offsetting policy, a price of £60 per tonne of regulated CO₂ per year, for a period of 30 years, has been used to calculate the contribution required. The calculated offsetting costs are outlined below:
- > 126.9 tonnes of CO₂ x £60 = £7,614
 - > £7,152 x 30-year period = **£228,420.**
- 7.4** The calculations above should be refined at the detailed design stage based on the final energy calculations.

8. SUMMARY

- 8.1** The overriding objective in the formulation of the energy strategy for Vastern Road is to maximise the reduction in development CO₂ emissions through the application of a series of measures which are cost-effective, viable and technically appropriate. Berkeley Homes (referred to henceforth as 'The Applicant') recognise the need to prioritise an energy strategy which takes into account a number of considerations, including user-friendliness of systems for residents, operational costs, and the reliability of adopted measures.
- 8.2** The proposed energy strategy for Vastern Road will therefore provide the following:
- > High standards of fabric efficiency, going significantly beyond the requirements of Part L 2013. This includes low air permeability rates and targeted thermal bridges;
 - > MVHR systems where required, providing heat recovery & cooling whilst contributing further to the overall CO₂ reduction of the development;
 - > Provision of a low carbon site heat network, future-proofed for a potential connection to a wider Reading area network;

- > Efficient & simple systems for residents to use;
- > High levels of control for resident comfort;
- > Application of PV panels to all suitable roof areas, providing generating potential for the overall development.

- 8.3** The development proposes to supply its heat from an Air Source Heat Pump (ASHP)-led site heat network, which utilises low carbon electricity. This delivers significant CO₂ savings to the development when assessing against the more accurate SAP 10.1 CO₂ emissions factors, with CO₂ continuing to decrease for the lifetime of the development as the electricity grid decarbonises further.
- 8.4** The proposed energy strategy seeks to prioritise measures which first and foremost reduce energy demand, before assessing means of energy supply and alternative generation sources. This is considered a best practice approach. However, the scheme will also incorporate low and zero carbon technologies to further reduce site wide CO₂ emissions as well as providing a source of on-site electricity generation.
- 8.5** Expected energy demands have been tested against the forward-looking SAP 10.1 methodology which more accurately reflects the decarbonisation of the electricity grid. CO₂ savings will therefore be delivered in the long-term through a future-proofed energy strategy, as set out in the table below.
- 8.6** In summary, the development is expected to achieve a **36.6%** reduction in Regulated CO₂ emissions. This goes beyond the requirements of the new RBC Local Plan for on-site reductions. For clarity, the strategy still enables compliance with Part L 2013 of Building Regulations when assessed under SAP 2012 emission factors.
- 8.7** The Applicant also acknowledges the requirements of Policy H5c, which seeks for the use of offsetting measures in order for the development to achieve a status of Zero Carbon once on-site measures have been accounted for. This results in a calculated offsetting fee of £228,420.

Regulated Carbon dioxide emissions (kg CO ₂ per annum)	
	SAP 10.1 Emission Factors
Baseline	200,200
After Energy Efficiency Measures	133,100
After Renewable Measures	126,900
Total % Savings (On-site)	36.6%

APPENDICES

Appendix A

SAP 10.1 Calculations

Appendix B

TER Worksheets for Representative Dwellings

Appendix C

DER Worksheets for Representative Dwellings

Appendix D

Estimate heating cost table

Indicative Energy Centre Layout

Indicative Roof Plant Layout

Appendix E

PV Panels – Indicative Roof Plan

Appendix A

SAP 10.1 Calculations

Appendix A - SAP 10.1 Calculations

SAP Outputs per Dwelling Type - SAP 10.1 Emission Factors

Description	Energy (kWh/yr)						Energy (kWh/m ² /yr)		Regulated CO ₂ (kg/m ² /yr)		Total CO ₂ (kg/m ² /yr)	
	Heat Pumps		Gas Boilers		Regulated Electrical	Unregulated Appliances & Cooking	TFEE	DFEE	TER	DER	TER	DER
	Space Heating	Hot Water	Space Heating	Hot Water								
A-2B-MF-NW	754	624	1,161	961	439	1,768	42.1	37.7	13.81	9.79	17.21	13.19
B-1B-MF-SE	294	548	453	844	313	1,258	34.3	34.1	13.58	10.08	16.98	13.48
B-2B-MF-NW	506	624	780	961	429	1,768	42.1	37.7	13.81	9.79	17.21	13.19
B-2B-TF-SW	705	599	1,087	922	474	1,587	59.6	48.1	17.29	10.46	20.69	13.86
C-2B-GF-NENW	818	598	1,261	921	477	1,579	65.8	53.8	18.44	11.33	21.84	14.73
D-2B-ExFI-SE	677	608	1,043	937	509	1,652	52.3	45.7	15.96	9.98	19.36	13.38
E-1B-Ter-SWNW	569	549	877	846	370	1,267	61.8	49.3	18.64	11.14	22.04	14.54

Energy Demands & CO₂ Emissions - Vastern Road SAP 10.1 Emission Factors - PV NOT YET ADDED

Description	Unit Area (m ²)	No. Units	Energy (kWh/yr)						Energy (kWh/yr)		Regulated CO ₂ (kg/yr)		Total CO ₂ (kg/m ² /yr)	
			Space Heating	Hot Water	Space Heating	Hot Water	Regulated Electrical	Unregulated Appliances & Cooking	TFEE	DFEE	TER	DER	TER	DER
A-2B-MF-NW	71	27	20,350	16,835	31,357	25,940	11,861	47,736	80,423	72,061	26,368	18,703	32,860	25,195
B-1B-MF-SE	50	47	13,804	25,749	21,271	39,677	14,720	59,126	81,150	80,729	32,118	23,833	40,159	31,874
B-2B-MF-NW	71	42	21,264	26,187	32,767	40,351	18,016	74,256	125,102	112,095	41,017	29,093	51,115	39,192
B-2B-TF-SW	63	35	24,687	20,951	38,041	32,284	16,583	55,536	132,365	106,905	38,399	23,230	45,952	30,783
C-2B-GF-NENW	63	25	20,462	14,938	31,530	23,018	11,922	39,481	103,988	84,968	29,127	17,891	34,496	23,260
D-2B-ExFI-SE	66	18	12,178	10,943	18,765	16,862	9,167	29,741	62,230	54,319	18,989	11,873	23,034	15,918
E-1B-Ter-SWNW	51	15	8,538	8,238	13,157	12,694	5,557	18,998	46,969	37,498	14,168	8,466	16,751	11,050
TOTAL (Residential)			121,284	123,841	186,887	190,827	87,826	324,874	632,227	548,576	200,185	133,088	244,368	177,271
Area Weighted Average (/m²)									48.7	42.2	15.4	10.2	18.8	13.6
Improvement over Target									13.2%		33.5%		27.5%	

Appendix B

TER Worksheets for Representative Dwellings

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 Jonathan Peck	Assessor number	10160
Client		Last modified	09/12/2020
Address	2B MF Block B x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	70.72 (1a)	x	2.75 (2a)	=	194.48 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 70.72 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 194.48 (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) =	0.15 (8)

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

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.40 (18)
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Number of sides on which the dwelling is sheltered	3 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.78 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.31 (21)
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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)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.40	0.39	0.38	0.34	0.34	0.30	0.30	0.29	0.31	0.34	0.35	0.37 (22b)
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A (23a)
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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	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57 (24d)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57 (25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	1.00	1.98		(26)						
Window			9.12	1.33	12.09		(27)						
External wall			49.80	0.18	8.96		(29a)						
Party wall			41.40	0.00	0.00		(32)						
Total area of external elements ΣA, m ²			60.90				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	23.03	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						4.84	(36)						
Total fabric heat loss					(33) + (36) =	27.87	(37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 × (25)m × (5)	37.21	37.01	36.82	35.90	35.73	34.93	34.93	34.78	35.24	35.73	36.08	36.44	(38)
Heat transfer coefficient, W/K (37)m + (38)m	65.08	64.88	64.69	63.77	63.60	62.80	62.80	62.66	63.11	63.60	63.95	64.31	
										Average = Σ(39)1...12/12 =	63.77	(39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.92	0.92	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.90	0.90	0.91	
										Average = Σ(40)1...12/12 =	0.90	(40)	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N											2.26	(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$											87.96	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$	96.75	93.24	89.72	86.20	82.68	79.16	79.16	82.68	86.20	89.72	93.24	96.75	
											$\sum(44)1...12 =$	1055.49	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)	143.48	125.49	129.50	112.90	108.33	93.48	86.62	99.40	100.59	117.22	127.96	138.96	
											$\sum(45)1...12 =$	1383.92	(45)
Distribution loss $0.15 \times (45)m$	21.52	18.82	19.42	16.93	16.25	14.02	12.99	14.91	15.09	17.58	19.19	20.84	(46)
Storage volume (litres) including any solar or WWHRS storage within same vessel											3.00	(47)	
Water storage loss:													
a) If manufacturer's declared loss factor is known (kWh/day)											0.26	(48)	
Temperature factor from Table 2b											0.54	(49)	
Energy lost from water storage (kWh/day) $(48) \times (49)$											0.14	(50)	
Enter (50) or (54) in (55)											0.14	(55)	
Water storage loss calculated for each month $(55) \times (41)m$	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(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)
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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)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

171.10	150.44	157.11	139.62	135.94	120.21	114.24	127.02	127.31	144.84	154.69	166.57	(62)
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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)
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Output from water heater for each month (kWh/month) $(62)m + (63)m$

171.10	150.44	157.11	139.62	135.94	120.21	114.24	127.02	127.31	144.84	154.69	166.57	
$\Sigma(64)1...12 =$											1709.09	(64)

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

69.80	61.68	65.15	58.92	58.11	52.46	50.90	55.14	54.83	61.07	63.93	68.30	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												
113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

19.38	17.21	14.00	10.60	7.92	6.69	7.23	9.39	12.61	16.01	18.68	19.92	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

198.97	201.04	195.83	184.76	170.77	157.63	148.85	146.79	151.99	163.07	177.05	190.19	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	(69)
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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)
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Losses e.g. evaporation (Table 5)

-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	(71)
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Water heating gains (Table 5)

93.82	91.79	87.57	81.83	78.11	72.87	68.41	74.12	76.15	82.08	88.79	91.80	(72)
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Total internal gains $(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m$

372.12	369.99	357.35	337.14	316.76	297.14	284.44	290.25	300.70	321.11	344.47	361.86	(73)
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6. Solar gains

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
NorthWest	0.77	x	9.12	x	11.28	x 0.9 x	0.63	x	0.70	=	31.45	(81)

Solar gains in watts $\Sigma(74)m... (82)m$

31.45	64.01	115.33	189.41	254.60	271.43	253.92	202.43	140.53	78.23	39.57	25.68	(83)
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Total gains - internal and solar $(73)m + (83)m$

403.57	434.00	472.68	526.54	571.36	568.57	538.36	492.68	441.23	399.34	384.04	387.54	(84)
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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	1.00	0.99	0.97	0.87	0.68	0.51	0.58	0.86	0.98	1.00	1.00	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

20.05	20.15	20.35	20.64	20.87	20.98	21.00	20.99	20.92	20.63	20.30	20.04	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.15	20.15	20.16	20.17	20.17	20.18	20.18	20.18	20.17	20.17	20.16	20.16	(88)
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Utilisation factor for gains for rest of dwelling n2,m

1.00	1.00	0.99	0.96	0.83	0.60	0.42	0.48	0.79	0.97	1.00	1.00	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.87	19.02	19.31	19.73	20.04	20.16	20.18	20.18	20.11	19.72	19.24	18.86	(90)
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Living area fraction

Living area ÷ (4) = 0.48 (91)

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

19.44	19.57	19.81	20.17	20.44	20.56	20.57	20.57	20.50	20.16	19.75	19.43	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.44	19.57	19.81	20.17	20.44	20.56	20.57	20.57	20.50	20.16	19.75	19.43	(93)
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8. Space heating requirement

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Utilisation factor for gains, ηm

1.00	1.00	0.99	0.96	0.85	0.64	0.46	0.53	0.82	0.97	0.99	1.00	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

402.47	431.94	466.98	503.08	484.57	364.14	248.34	258.94	361.80	388.44	381.92	386.71	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

985.47	951.58	861.09	718.41	555.99	374.13	249.47	261.33	403.80	607.79	808.95	979.25	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

433.75	349.19	293.22	155.04	53.14	0.00	0.00	0.00	0.00	163.20	307.46	440.85	
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Σ(98)1...5, 10...12 = 2195.84 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 31.05 (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

463.90	373.47	313.60	165.82	56.83	0.00	0.00	0.00	0.00	174.54	328.83	471.50	
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Σ(211)1...5, 10...12 = 2348.49 (211)

Water heating

Efficiency of water heater

87.19	86.99	86.46	85.09	82.54	79.80	79.80	79.80	79.80	85.13	86.61	87.29	(217)
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Water heating fuel, kWh/month

196.23	172.94	181.73	164.08	164.70	150.63	143.16	159.17	159.54	170.14	178.59	190.83	
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Σ(219a)1...12 = 2031.73 (219)

Annual totals

Space heating fuel - main system 1

2348.49

Water heating fuel

2031.73

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)	342.21	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	4797.43 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2348.49	x	3.48	x 0.01 =	81.73	(240)
Water heating	2031.73	x	3.48	x 0.01 =	70.70	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	342.21	x	13.19	x 0.01 =	45.14	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		327.46	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.19	(257)
SAP value	83.42	
SAP rating (section 13)	83	(258)
SAP band	B	

12a. CO₂ 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	2348.49	x	0.216	=	507.27	(261)
Water heating	2031.73	x	0.216	=	438.85	(264)
Space and water heating			(261) + (262) + (263) + (264) =		946.13	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	342.21	x	0.519	=	177.61	(268)
Total CO ₂ , kg/year			(265)...(271) =		1162.66	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		16.44	(273)
EI value					86.54	
EI rating (section 14)					87	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2348.49	x	1.22	=	2865.16	(261)
Water heating	2031.73	x	1.22	=	2478.71	(264)
Space and water heating			(261) + (262) + (263) + (264) =		5343.87	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	342.21	x	3.07	=	1050.58	(268)
Primary energy kWh/year					6624.70	(272)
Dwelling primary energy rate kWh/m ² /year					93.68	(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 Jonathan Peck	Assessor number	10160
Client		Last modified	09/12/2020
Address	1B MF Block B x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	50.32 (1a) x	2.75 (2a) =	138.38 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 50.32 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	138.38 (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	2 x 10 =	20 (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) = 20 ÷ (5) = 0.14 (8)

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

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.39 (18)
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Number of sides on which the dwelling is sheltered	3 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.78 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.31 (21)
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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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.39	0.38	0.37	0.34	0.33	0.29	0.29	0.28	0.31	0.33	0.34	0.36
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A (23a)
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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	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.58	0.57	0.57	0.56	0.55	0.54	0.54	0.54	0.55	0.55	0.56	0.56
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	1.00	1.98		(26)						
Window			7.09	1.33	9.40		(27)						
External wall			32.93	0.18	5.93		(29a)						
Party wall			43.20	0.00	0.00		(32)						
Total area of external elements ΣA, m ²			42.00				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	17.31	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						3.40	(36)						
Total fabric heat loss					(33) + (36) =	20.71	(37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 × (25)m × (5)	26.30	26.17	26.04	25.42	25.30	24.76	24.76	24.66	24.97	25.30	25.53	25.78	(38)
Heat transfer coefficient, W/K (37)m + (38)m	47.01	46.88	46.74	46.12	46.01	45.47	45.47	45.37	45.67	46.01	46.24	46.49	
	Average = Σ(39)1...12/12 =											46.12	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.93	0.93	0.93	0.92	0.91	0.90	0.90	0.90	0.91	0.91	0.92	0.92	
	Average = Σ(40)1...12/12 =											0.92	(40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.70											(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$	74.56											(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
	82.02	79.04	76.06	73.07	70.09	67.11	67.11	70.09	73.07	76.06	79.04	82.02	
	$\Sigma(44)_{1...12} =$											894.76	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)													
	121.63	106.38	109.78	95.71	91.83	79.24	73.43	84.26	85.27	99.37	108.47	117.80	
	$\Sigma(45)_{1...12} =$											1173.18	(45)
Distribution loss $0.15 \times (45)_m$													
	18.25	15.96	16.47	14.36	13.77	11.89	11.01	12.64	12.79	14.91	16.27	17.67	(46)
Storage volume (litres) including any solar or WWHRS storage within same vessel												3.00	(47)
Water storage loss:													
a) If manufacturer's declared loss factor is known (kWh/day)												0.26	(48)
Temperature factor from Table 2b												0.54	(49)
Energy lost from water storage (kWh/day) $(48) \times (49)$												0.14	(50)
Enter (50) or (54) in (55)												0.14	(55)
Water storage loss calculated for each month $(55) \times (41)_m$													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS $(56)_m \times [(47) - V_s] \div (47)$, else (56)													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(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)
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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)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

149.25	131.33	137.39	122.43	119.45	105.97	101.05	111.88	112.00	126.99	135.20	145.41	(62)
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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)
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Output from water heater for each month (kWh/month) $(62)m + (63)m$

149.25	131.33	137.39	122.43	119.45	105.97	101.05	111.88	112.00	126.99	135.20	145.41	
$\Sigma(64)1...12 =$											1498.35	(64)

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

62.54	55.33	58.59	53.20	52.63	47.73	46.51	50.11	49.73	55.14	57.45	61.26	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												
84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

14.14	12.56	10.21	7.73	5.78	4.88	5.27	6.85	9.20	11.68	13.63	14.53	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

148.07	149.60	145.73	137.49	127.08	117.30	110.77	109.23	113.11	121.35	131.75	141.53	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	(69)
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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)

-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	(71)
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Water heating gains (Table 5)

84.06	82.33	78.76	73.89	70.74	66.29	62.51	67.35	69.07	74.11	79.79	82.34	(72)
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Total internal gains $(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m$

297.75	295.99	286.19	270.61	255.09	239.97	230.05	234.94	242.87	258.63	276.67	289.90	(73)
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6. Solar gains

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
SouthEast	0.77	x	7.09	x	36.79	x 0.9 x	0.63	x	0.70	=	79.72	(77)

Solar gains in watts $\Sigma(74)m... (82)m$

79.72	135.80	185.81	230.23	257.87	256.01	246.82	226.19	201.19	150.09	95.49	68.23	(83)
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Total gains - internal and solar $(73)m + (83)m$

377.48	431.79	472.00	500.83	512.96	495.98	476.87	461.13	444.06	408.72	372.16	358.13	(84)
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7. Mean internal temperature (heating season)

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

												21.00	(85)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		

Utilisation factor for gains for living area n1,m (see Table 9a)

0.99	0.98	0.96	0.90	0.77	0.58	0.42	0.45	0.68	0.92	0.98	0.99	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

20.20	20.36	20.57	20.79	20.94	20.99	21.00	21.00	20.98	20.80	20.46	20.17	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.14	20.14	20.14	20.15	20.16	20.16	20.16	20.17	20.16	20.16	20.15	20.15
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(88)

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.98	0.95	0.87	0.72	0.51	0.34	0.37	0.61	0.89	0.98	0.99
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(89)

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

19.08	19.31	19.61	19.92	20.10	20.16	20.16	20.17	20.14	19.94	19.47	19.05
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

(90)

Living area fraction

Living area ÷ (4) = 0.49

(91)

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

19.63	19.82	20.08	20.35	20.51	20.57	20.57	20.57	20.55	20.36	19.95	19.60
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(92)

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

19.63	19.82	20.08	20.35	20.51	20.57	20.57	20.57	20.55	20.36	19.95	19.60
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(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	0.74	0.54	0.38	0.41	0.64	0.90	0.98	0.99
------	------	------	------	------	------	------	------	------	------	------	------

(94)

Useful gains, ηmGm, W (94)m x (84)m

373.62	422.18	448.44	440.61	380.09	268.16	180.33	188.84	286.06	365.95	363.61	355.32
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(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]

720.76	699.58	634.54	527.93	405.21	271.25	180.62	189.32	294.64	448.92	594.41	715.84
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(97)

Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

258.28	186.41	138.46	62.87	18.69	0.00	0.00	0.00	0.00	61.73	166.17	268.23
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Σ(98)1...5, 10...12 = 1160.83

(98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 23.07

(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

276.23	199.37	148.08	67.24	19.99	0.00	0.00	0.00	0.00	66.02	177.72	286.88
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Σ(211)1...5, 10...12 = 1241.53

(211)

Water heating

Efficiency of water heater

86.26	85.75	84.83	83.13	81.10	79.80	79.80	79.80	79.80	83.01	85.37	86.43
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(217)

Water heating fuel, kWh/month

173.02	153.15	161.96	147.27	147.29	132.80	126.63	140.20	140.35	152.98	158.38	168.25
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Σ(219a)1...12 = 1802.27

(219)

Annual totals

Space heating fuel - main system 1

1241.53

Water heating fuel

1802.27

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)	249.75	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) = 3368.55	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1241.53	x	3.48	x 0.01 =	43.21	(240)
Water heating	1802.27	x	3.48	x 0.01 =	62.72	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	249.75	x	13.19	x 0.01 =	32.94	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		268.76	(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	83.48	
SAP rating (section 13)	83	(258)
SAP band	B	

12a. CO₂ 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	1241.53	x	0.216	=	268.17	(261)
Water heating	1802.27	x	0.216	=	389.29	(264)
Space and water heating			(261) + (262) + (263) + (264) =		657.46	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	249.75	x	0.519	=	129.62	(268)
Total CO ₂ , kg/year			(265)...(271) =		826.00	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		16.42	(273)
EI value					88.39	
EI rating (section 14)					88	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1241.53	x	1.22	=	1514.67	(261)
Water heating	1802.27	x	1.22	=	2198.77	(264)
Space and water heating			(261) + (262) + (263) + (264) =		3713.44	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	249.75	x	3.07	=	766.72	(268)
Primary energy kWh/year					4710.41	(272)
Dwelling primary energy rate kWh/m ² /year					93.61	(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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	2B MF Block A x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	70.72 (1a)	x	2.75 (2a)	=	194.48 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 70.72 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 194.48 (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) =	0.15 (8)

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

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.40 (18)
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Number of sides on which the dwelling is sheltered	3 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.78 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.31 (21)
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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)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.40	0.39	0.38	0.34	0.34	0.30	0.30	0.29	0.31	0.34	0.35	0.37 (22b)
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A (23a)
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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	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57 (24d)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57 (25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	1.00	1.98		(26)						
Window			9.12	1.33	12.09		(27)						
External wall			49.80	0.18	8.96		(29a)						
Party wall			41.40	0.00	0.00		(32)						
Total area of external elements ΣA, m ²			60.90				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	23.03	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						4.84	(36)						
Total fabric heat loss					(33) + (36) =	27.87	(37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 × (25)m × (5)	37.21	37.01	36.82	35.90	35.73	34.93	34.93	34.78	35.24	35.73	36.08	36.44	(38)
Heat transfer coefficient, W/K (37)m + (38)m	65.08	64.88	64.69	63.77	63.60	62.80	62.80	62.66	63.11	63.60	63.95	64.31	
										Average = Σ(39)1...12/12 =	63.77	(39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.92	0.92	0.91	0.90	0.90	0.89	0.89	0.89	0.89	0.90	0.90	0.91	
										Average = Σ(40)1...12/12 =	0.90	(40)	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N												2.26	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36												87.96	(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)	96.75	93.24	89.72	86.20	82.68	79.16	79.16	82.68	86.20	89.72	93.24	96.75	
													Σ(44)1...12 = 1055.49 (44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	143.48	125.49	129.50	112.90	108.33	93.48	86.62	99.40	100.59	117.22	127.96	138.96	
													Σ(45)1...12 = 1383.92 (45)
Distribution loss 0.15 x (45)m	21.52	18.82	19.42	16.93	16.25	14.02	12.99	14.91	15.09	17.58	19.19	20.84	(46)
Storage volume (litres) including any solar or WWHRS storage within same vessel												3.00	(47)
Water storage loss:													
a) If manufacturer's declared loss factor is known (kWh/day)												0.26	(48)
Temperature factor from Table 2b												0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)												0.14	(50)
Enter (50) or (54) in (55)												0.14	(55)
Water storage loss calculated for each month (55) x (41)m	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(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)
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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)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

171.10	150.44	157.11	139.62	135.94	120.21	114.24	127.02	127.31	144.84	154.69	166.57	(62)
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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)
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Output from water heater for each month (kWh/month) $(62)m + (63)m$

171.10	150.44	157.11	139.62	135.94	120.21	114.24	127.02	127.31	144.84	154.69	166.57	
$\Sigma(64)1...12 =$											1709.09	(64)

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

69.80	61.68	65.15	58.92	58.11	52.46	50.90	55.14	54.83	61.07	63.93	68.30	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)												
113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	(66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

19.38	17.21	14.00	10.60	7.92	6.69	7.23	9.39	12.61	16.01	18.68	19.92	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

198.97	201.04	195.83	184.76	170.77	157.63	148.85	146.79	151.99	163.07	177.05	190.19	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	(69)
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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)
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Losses e.g. evaporation (Table 5)

-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	(71)
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Water heating gains (Table 5)

93.82	91.79	87.57	81.83	78.11	72.87	68.41	74.12	76.15	82.08	88.79	91.80	(72)
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Total internal gains $(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m$

372.12	369.99	357.35	337.14	316.76	297.14	284.44	290.25	300.70	321.11	344.47	361.86	(73)
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6. Solar gains

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
NorthWest	0.77	x	9.12	x	11.28	x 0.9 x	0.63	x	0.70	=	31.45	(81)

Solar gains in watts $\Sigma(74)m... (82)m$

31.45	64.01	115.33	189.41	254.60	271.43	253.92	202.43	140.53	78.23	39.57	25.68	(83)
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Total gains - internal and solar $(73)m + (83)m$

403.57	434.00	472.68	526.54	571.36	568.57	538.36	492.68	441.23	399.34	384.04	387.54	(84)
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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	1.00	0.99	0.97	0.87	0.68	0.51	0.58	0.86	0.98	1.00	1.00	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

20.05	20.15	20.35	20.64	20.87	20.98	21.00	20.99	20.92	20.63	20.30	20.04	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.15	20.15	20.16	20.17	20.17	20.18	20.18	20.18	20.17	20.17	20.16	20.16	(88)
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Utilisation factor for gains for rest of dwelling n2,m

1.00	1.00	0.99	0.96	0.83	0.60	0.42	0.48	0.79	0.97	1.00	1.00	(89)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

18.87	19.02	19.31	19.73	20.04	20.16	20.18	20.18	20.11	19.72	19.24	18.86	(90)
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Living area fraction

Living area ÷ (4) = 0.48 (91)

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

19.44	19.57	19.81	20.17	20.44	20.56	20.57	20.57	20.50	20.16	19.75	19.43	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.44	19.57	19.81	20.17	20.44	20.56	20.57	20.57	20.50	20.16	19.75	19.43	(93)
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8. Space heating requirement

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Utilisation factor for gains, ηm

1.00	1.00	0.99	0.96	0.85	0.64	0.46	0.53	0.82	0.97	0.99	1.00	(94)
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Useful gains, ηmGm, W (94)m x (84)m

402.47	431.94	466.98	503.08	484.57	364.14	248.34	258.94	361.80	388.44	381.92	386.71	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

985.47	951.58	861.09	718.41	555.99	374.13	249.47	261.33	403.80	607.79	808.95	979.25	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

433.75	349.19	293.22	155.04	53.14	0.00	0.00	0.00	0.00	163.20	307.46	440.85	
										Σ(98)1...5, 10...12 =	2195.84	(98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 31.05 (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

463.90	373.47	313.60	165.82	56.83	0.00	0.00	0.00	0.00	174.54	328.83	471.50	
										Σ(211)1...5, 10...12 =	2348.49	(211)

Water heating

Efficiency of water heater

87.19	86.99	86.46	85.09	82.54	79.80	79.80	79.80	79.80	85.13	86.61	87.29	(217)
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Water heating fuel, kWh/month

196.23	172.94	181.73	164.08	164.70	150.63	143.16	159.17	159.54	170.14	178.59	190.83	
										Σ(219a)1...12 =	2031.73	(219)

Annual totals

Space heating fuel - main system 1

2348.49

Water heating fuel

2031.73

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)	342.21	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	4797.43 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2348.49	x	3.48	x 0.01 =	81.73	(240)
Water heating	2031.73	x	3.48	x 0.01 =	70.70	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	342.21	x	13.19	x 0.01 =	45.14	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		327.46	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.19	(257)
SAP value	83.42	
SAP rating (section 13)	83	(258)
SAP band	B	

12a. CO₂ 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	2348.49	x	0.216	=	507.27	(261)
Water heating	2031.73	x	0.216	=	438.85	(264)
Space and water heating			(261) + (262) + (263) + (264) =		946.13	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	342.21	x	0.519	=	177.61	(268)
Total CO ₂ , kg/year			(265)...(271) =		1162.66	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		16.44	(273)
EI value					86.54	
EI rating (section 14)					87	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2348.49	x	1.22	=	2865.16	(261)
Water heating	2031.73	x	1.22	=	2478.71	(264)
Space and water heating			(261) + (262) + (263) + (264) =		5343.87	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	342.21	x	3.07	=	1050.58	(268)
Primary energy kWh/year					6624.70	(272)
Dwelling primary energy rate kWh/m ² /year					93.68	(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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	1B Terrace Block E x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	50.66 (1a) x	2.75 (2a) =	139.32 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 50.66 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	139.32 (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	2 x 10 =	20 (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) = 20 ÷ (5) = 0.14 (8)

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

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.39 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.33 (21)
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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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.43	0.42	0.41	0.37	0.36	0.32	0.32	0.31	0.33	0.36	0.38	0.39
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	N/A (23a)
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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

0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.55	0.56	0.56	0.57	0.58
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.59	0.59	0.58	0.57	0.56	0.55	0.55	0.55	0.56	0.56	0.57	0.58
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	x 1.00	= 1.98		(26)						
Window			10.56	x 1.33	= 14.00		(27)						
External wall			49.56	x 0.18	= 8.92		(29a)						
Party wall			24.00	x 0.00	= 0.00		(32)						
Roof			14.36	x 0.13	= 1.87		(30)						
Total area of external elements ΣA, m ²			76.46				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	26.77	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						14.87	(36)						
Total fabric heat loss					(33) + (36) =	41.64	(37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	27.17	27.01	26.85	26.10	25.96	25.31	25.31	25.19	25.56	25.96	26.24	26.54	(38)
Heat transfer coefficient, W/K (37)m + (38)m	68.81	68.64	68.48	67.74	67.60	66.95	66.95	66.82	67.20	67.60	67.88	68.18	
	Average = Σ(39)1...12/12 =										67.74	(39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.36	1.35	1.35	1.34	1.33	1.32	1.32	1.32	1.33	1.33	1.34	1.35	
	Average = Σ(40)1...12/12 =										1.34	(40)	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N											1.71	(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$											74.80	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
	82.28	79.29	76.30	73.31	70.31	67.32	67.32	70.31	73.31	76.30	79.29	82.28	
											$\sum(44)1...12 =$	897.62	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)													
	122.02	106.72	110.13	96.01	92.12	79.50	73.67	84.53	85.54	99.69	108.82	118.17	
											$\sum(45)1...12 =$	1176.92	(45)
Distribution loss $0.15 \times (45)m$													
	18.30	16.01	16.52	14.40	13.82	11.92	11.05	12.68	12.83	14.95	16.32	17.73	(46)
Storage volume (litres) including any solar or WWHRS storage within same vessel											3.00	(47)	
Water storage loss:													
a) If manufacturer's declared loss factor is known (kWh/day)											0.26	(48)	
Temperature factor from Table 2b											0.54	(49)	
Energy lost from water storage (kWh/day) $(48) \times (49)$											0.14	(50)	
Enter (50) or (54) in (55)											0.14	(55)	
Water storage loss calculated for each month $(55) \times (41)m$													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(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
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 (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
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 (61)

Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

149.64	131.67	137.74	122.74	119.74	106.22	101.28	112.15	112.27	127.31	135.55	145.79
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 (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
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 (63)

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

149.64	131.67	137.74	122.74	119.74	106.22	101.28	112.15	112.27	127.31	135.55	145.79
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

$\Sigma(64)1...12 =$ 1502.10 (64)

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

62.67	55.44	58.71	53.31	52.73	47.81	46.59	50.20	49.82	55.24	57.56	61.39
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 (65)

5. Internal gains

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Metabolic gains (Table 5)

85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48
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 (66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

13.32	11.83	9.62	7.29	5.45	4.60	4.97	6.46	8.67	11.01	12.84	13.69
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 (67)

Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

148.95	150.49	146.60	138.31	127.84	118.00	111.43	109.89	113.78	122.07	132.54	142.38
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 (68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55
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 (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
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 (70)

Losses e.g. evaporation (Table 5)

-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38
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 (71)

Water heating gains (Table 5)

84.23	82.50	78.91	74.03	70.87	66.41	62.62	67.47	69.20	74.25	79.95	82.51
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 (72)

Total internal gains $(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m$

298.14	296.47	286.78	271.27	255.80	240.65	230.66	235.46	243.29	258.97	276.98	290.22
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 (73)

6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W
SouthWest	0.77	6.72	36.79	0.63	0.70	75.56
NorthWest	0.77	3.84	11.28	0.63	0.70	13.24

 (79) (81)

Solar gains in watts $\Sigma(74)m... (82)m$

88.81	155.67	224.67	297.96	351.61	356.93	340.85	299.62	249.86	175.19	107.17	75.48
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 (83)

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

386.95	452.14	511.45	569.23	607.41	597.58	571.51	535.08	493.15	434.16	384.15	365.70
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 (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	0.99	0.97	0.93	0.83	0.66	0.50	0.55	0.79	0.95	0.99	1.00
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 (86)

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

19.64	19.82	20.11	20.48	20.78	20.94	20.99	20.98	20.87	20.48	19.99	19.60	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.80	19.80	19.80	19.81	19.81	19.82	19.82	19.83	19.82	19.81	19.81	19.81	(88)
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Utilisation factor for gains for rest of dwelling n2,m

0.99	0.98	0.96	0.91	0.77	0.56	0.37	0.42	0.70	0.93	0.98	0.99	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.01	18.29	18.71	19.22	19.61	19.79	19.82	19.82	19.72	19.24	18.54	17.97	(90)
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Living area fraction

Living area ÷ (4) = 0.62 (91)

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

19.02	19.24	19.58	20.00	20.33	20.50	20.54	20.54	20.43	20.01	19.44	18.98	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.02	19.24	19.58	20.00	20.33	20.50	20.54	20.54	20.43	20.01	19.44	18.98	(93)
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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	0.91	0.80	0.62	0.45	0.50	0.75	0.93	0.98	0.99	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

383.49	444.15	492.15	518.16	486.21	372.07	259.58	269.59	371.35	405.62	377.60	363.10	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1012.74	984.38	895.80	752.14	583.60	395.25	264.03	276.59	425.60	636.04	837.59	1007.78	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

468.16	363.03	300.32	168.46	72.45	0.00	0.00	0.00	0.00	171.43	331.19	479.64	
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Σ(98)1...5, 10...12 = 2354.69 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 46.48 (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

500.71	388.27	321.20	180.17	77.49	0.00	0.00	0.00	0.00	183.35	354.21	512.99	
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Σ(211)1...5, 10...12 = 2518.38 (211)

Water heating

Efficiency of water heater

87.65	87.38	86.84	85.66	83.52	79.80	79.80	79.80	79.80	85.61	87.11	87.76	(217)
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Water heating fuel, kWh/month

170.72	150.68	158.62	143.29	143.37	133.11	126.92	140.54	140.69	148.71	155.61	166.13	
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Σ(219a)1...12 = 1778.37 (219)

Annual totals

Space heating fuel - main system 1		2518.38	
Water heating fuel		1778.37	
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)		235.28	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	4607.03	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2518.38	x	3.48	x 0.01 =	87.64	(240)
Water heating	1778.37	x	3.48	x 0.01 =	61.89	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	235.28	x	13.19	x 0.01 =	31.03	(250)
Additional standing charges					120.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	310.45	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.36	(257)
SAP value	80.99	
SAP rating (section 13)	81	(258)
SAP band	B	

12a. CO₂ 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	2518.38	x	0.216	=	543.97	(261)
Water heating	1778.37	x	0.216	=	384.13	(264)
Space and water heating			(261) + (262) + (263) + (264) =		928.10	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	235.28	x	0.519	=	122.11	(268)
Total CO ₂ , kg/year			(265)...(271) =		1089.13	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		21.50	(273)
EI value					84.74	
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	2518.38	x	1.22	=	3072.43	(261)
Water heating	1778.37	x	1.22	=	2169.62	(264)
Space and water heating			(261) + (262) + (263) + (264) =		5242.04	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	235.28	x	3.07	=	722.31	(268)
Primary energy kWh/year					6194.60	(272)
Dwelling primary energy rate kWh/m ² /year					122.28	(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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	2B Exposed Block D x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	66.09 (1a)	x	2.75 (2a)	=	181.75 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 66.09 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 181.75 (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	2	x 10 =	20 (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) = 20	÷ (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, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.36 (18)
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Number of sides on which the dwelling is sheltered	3 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.78 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.28 (21)
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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)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.36	0.35	0.34	0.31	0.30	0.27	0.27	0.26	0.28	0.30	0.31	0.33 (22b)
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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	0.54	0.54	0.53	0.54	0.54	0.55	0.55 (24d)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.56	0.56	0.56	0.55	0.54	0.54	0.54	0.53	0.54	0.54	0.55	0.55 (25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	x 1.00	= 1.98		(26)						
Window			8.16	x 1.33	= 10.82		(27)						
Exposed floor			66.09	x 0.13	= 8.59		(28b)						
External wall			56.46	x 0.18	= 10.16		(29a)						
Party wall			32.40	x 0.00	= 0.00		(32)						
Total area of external elements ΣA, m ²			132.69				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	31.55	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						11.68	(36)						
Total fabric heat loss					(33) + (36) =	43.23	(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)	33.78	33.64	33.49	32.81	32.69	32.10	32.10	31.99	32.32	32.69	32.94	33.21	(38)
Heat transfer coefficient, W/K (37)m + (38)m	77.02	76.87	76.73	76.05	75.92	75.33	75.33	75.22	75.56	75.92	76.18	76.45	
	Average = Σ(39)1...12/12 =										76.05	(39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.17	1.16	1.16	1.15	1.15	1.14	1.14	1.14	1.14	1.15	1.15	1.16	
	Average = Σ(40)1...12/12 =										1.15	(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												2.15	(42)
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$												85.21	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m}$ = factor from Table 1c x (43)													
	93.73	90.32	86.91	83.50	80.09	76.68	76.68	80.09	83.50	86.91	90.32	93.73	
	$\sum(44)1...12 =$											1022.46	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)													
	138.99	121.56	125.44	109.36	104.94	90.55	83.91	96.29	97.44	113.56	123.96	134.61	
	$\sum(45)1...12 =$											1340.61	(45)
Distribution loss $0.15 \times (45)m$													
	20.85	18.23	18.82	16.40	15.74	13.58	12.59	14.44	14.62	17.03	18.59	20.19	(46)
Storage volume (litres) including any solar or WWHRS storage within same vessel												3.00	(47)
Water storage loss:													
a) If manufacturer's declared loss factor is known (kWh/day)												0.26	(48)
Temperature factor from Table 2b												0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)												0.14	(50)
Enter (50) or (54) in (55)												0.14	(55)
Water storage loss calculated for each month (55) x (41)m													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - V_s] ÷ (47), else (56)													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(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
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 (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
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 (61)

Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

166.61	146.51	153.06	136.09	132.56	117.28	111.53	123.91	124.17	141.17	150.68	162.22
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 (62)

Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
------	------	------	------	------	------	------	------	------	------	------	------

 (63)

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

166.61	146.51	153.06	136.09	132.56	117.28	111.53	123.91	124.17	141.17	150.68	162.22
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

Σ(64)1...12 = 1665.79 (64)

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

68.31	60.38	63.80	57.75	56.99	51.49	49.99	54.11	53.78	59.85	62.60	66.85
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 (65)

5. Internal gains

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Metabolic gains (Table 5)

107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38
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 (66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

18.49	16.42	13.35	10.11	7.56	6.38	6.89	8.96	12.03	15.27	17.82	19.00
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 (67)

Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

188.01	189.96	185.04	174.57	161.36	148.95	140.65	138.70	143.62	154.08	167.29	179.71
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 (68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (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)

-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (71)

Water heating gains (Table 5)

91.81	89.85	85.76	80.20	76.59	71.51	67.20	72.73	74.69	80.45	86.94	89.85
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 (72)

Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

356.52	354.44	342.37	323.10	303.73	285.05	272.95	278.60	288.55	308.01	330.27	346.78
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 (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

SouthEast 0.77 x 8.16 x 36.79 x 0.9 x 0.63 x 0.70 = 91.76 (77)

Solar gains in watts Σ(74)m...(82)m

91.76	156.30	213.85	264.97	296.79	294.64	284.07	260.33	231.55	172.74	109.90	78.52
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 (83)

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

448.28	510.73	556.22	588.07	600.52	579.70	557.02	538.93	520.10	480.75	440.17	425.30
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 (84)

7. Mean internal temperature (heating season)

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

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Utilisation factor for gains for living area n1,m (see Table 9a)

1.00	0.99	0.98	0.96	0.89	0.75	0.58	0.62	0.84	0.97	0.99	1.00
------	------	------	------	------	------	------	------	------	------	------	------

 (86)

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

19.81	19.96	20.20	20.49	20.76	20.93	20.99	20.98	20.88	20.54	20.12	19.78	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.95	19.95	19.95	19.96	19.96	19.97	19.97	19.97	19.97	19.96	19.96	19.95	(88)
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Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.98	0.94	0.85	0.66	0.45	0.49	0.76	0.95	0.99	1.00	(89)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

18.37	18.60	18.94	19.36	19.72	19.92	19.96	19.96	19.87	19.43	18.83	18.33	(90)
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Living area fraction

Living area ÷ (4) = 0.43 (91)

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

18.99	19.18	19.48	19.85	20.16	20.35	20.40	20.40	20.30	19.91	19.38	18.95	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.99	19.18	19.48	19.85	20.16	20.35	20.40	20.40	20.30	19.91	19.38	18.95	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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Utilisation factor for gains, ηm

0.99	0.99	0.98	0.94	0.86	0.70	0.51	0.54	0.79	0.95	0.99	1.00	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

445.55	504.63	542.34	553.72	517.11	403.15	281.41	293.55	409.91	456.18	434.80	423.28	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1131.21	1097.89	995.68	832.52	642.65	433.46	286.28	300.66	468.39	706.46	935.35	1127.66	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

510.13	398.67	337.28	200.74	93.40	0.00	0.00	0.00	0.00	186.21	360.39	524.06	
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Σ(98)1...5, 10...12 = 2610.88 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 39.50 (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	
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Space heating fuel (main system 1), kWh/month

545.59	426.39	360.73	214.70	99.89	0.00	0.00	0.00	0.00	199.15	385.45	560.49	
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Σ(211)1...5, 10...12 = 2792.39 (211)

Water heating

Efficiency of water heater

87.61	87.35	86.86	85.85	83.90	79.80	79.80	79.80	79.80	85.55	87.06	87.72	(217)
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Water heating fuel, kWh/month

190.18	167.72	176.21	158.52	157.99	146.97	139.76	155.27	155.60	165.01	173.08	184.94	
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Σ(219a)1...12 = 1971.25 (219)

Annual totals

Space heating fuel - main system 1

2792.39

Water heating fuel		1971.25	
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)		326.48	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	5165.12	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2792.39	x	3.48	x 0.01 =	97.18	(240)
Water heating	1971.25	x	3.48	x 0.01 =	68.60	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	326.48	x	13.19	x 0.01 =	43.06	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		338.73	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.28	(257)
SAP value	82.14	
SAP rating (section 13)	82	(258)
SAP band	B	

12a. CO₂ 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	2792.39	x	0.216	=	603.16	(261)
Water heating	1971.25	x	0.216	=	425.79	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1028.94	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	326.48	x	0.519	=	169.44	(268)
Total CO ₂ , kg/year			(265)...(271) =		1237.31	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		18.72	(273)
EI value					85.08	
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	2792.39	x	1.22	=	3406.71	(261)
Water heating	1971.25	x	1.22	=	2404.92	(264)
Space and water heating			(261) + (262) + (263) + (264) =		5811.63	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	326.48	x	3.07	=	1002.30	(268)
Primary energy kWh/year					7044.18	(272)
Dwelling primary energy rate kWh/m ² /year					106.58	(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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	2B GF Block C x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	63.17 (1a)	x	2.75 (2a)	=	173.72 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 63.17 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 173.72 (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	2	x 10 =	20 (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) = 20	÷ (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, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.37 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
--	-------------------------------------

Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.31 (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)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.40	0.39	0.38	0.34	0.33	0.29	0.29	0.29	0.31	0.33	0.35	0.36 (22b)
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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	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57 (24d)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57 (25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	x 1.00	= 1.98		(26)						
Window			11.80	x 1.33	= 15.64		(27)						
Ground floor			63.17	x 0.13	= 8.21		(28a)						
External wall			82.52	x 0.18	= 14.85		(29a)						
Total area of external elements ΣA, m ²			159.47				(31)						
Fabric heat loss, W/K = Σ(A × U)						(26)...(30) + (32) =	40.69 (33)						
Heat capacity Cm = Σ(A × κ)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)						
Thermal mass parameter (TMP) in kJ/m ² K							250.00 (35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K							10.32 (36)						
Total fabric heat loss						(33) + (36) =	51.01 (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)	33.15	32.98	32.81	32.00	31.85	31.16	31.16	31.03	31.42	31.85	32.16	32.48	(38)
Heat transfer coefficient, W/K (37)m + (38)m	84.16	83.99	83.81	83.01	82.86	82.16	82.16	82.03	82.43	82.86	83.17	83.48	
	Average = Σ(39)1...12/12 =											83.01 (39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.33	1.33	1.33	1.31	1.31	1.30	1.30	1.30	1.30	1.31	1.32	1.32	
	Average = Σ(40)1...12/12 =											1.31 (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											2.07	(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$											83.36	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
	91.69	88.36	85.02	81.69	78.35	75.02	75.02	78.35	81.69	85.02	88.36	91.69	
											$\Sigma(44)1...12 =$	1000.26	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)													
	135.97	118.92	122.72	106.99	102.66	88.59	82.09	94.20	95.32	111.09	121.26	131.68	
											$\Sigma(45)1...12 =$	1311.50	(45)
Distribution loss $0.15 \times (45)m$													
	20.40	17.84	18.41	16.05	15.40	13.29	12.31	14.13	14.30	16.66	18.19	19.75	(46)
Storage volume (litres) including any solar or WWHRS storage within same vessel											3.00	(47)	
Water storage loss:													
a) If manufacturer's declared loss factor is known (kWh/day)											0.26	(48)	
Temperature factor from Table 2b											0.54	(49)	
Energy lost from water storage (kWh/day) $(48) \times (49)$											0.14	(50)	
Enter (50) or (54) in (55)											0.14	(55)	
Water storage loss calculated for each month $(55) \times (41)m$													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	(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)
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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 $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

163.59	143.87	150.34	133.72	130.28	115.31	109.71	121.82	122.05	138.71	147.99	159.30	(62)
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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) $(62)m + (63)m$

163.59	143.87	150.34	133.72	130.28	115.31	109.71	121.82	122.05	138.71	147.99	159.30	
$\Sigma(64)1...12 =$											1636.68	(64)

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

67.31	59.50	62.90	56.96	56.23	50.84	49.39	53.42	53.08	59.03	61.70	65.88	(65)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	--

Metabolic gains (Table 5)

103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	(66)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

16.38	14.55	11.83	8.96	6.69	5.65	6.11	7.94	10.65	13.53	15.79	16.83	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

180.87	182.74	178.01	167.94	155.23	143.29	135.31	133.43	138.16	148.23	160.94	172.88	(68)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	(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)

-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

90.46	88.54	84.54	79.10	75.58	70.61	66.38	71.79	73.72	79.34	85.70	88.55	(72)
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Total internal gains $(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m$

344.75	342.87	331.43	313.05	294.55	276.59	264.84	270.21	279.58	298.15	319.47	335.31	(73)
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6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
NorthWest	0.77	x 5.22	x 11.28	x 0.9	x 0.63	x 0.70	= 18.00 (81)
NorthEast	0.77	x 6.58	x 11.28	x 0.9	x 0.63	x 0.70	= 22.69 (75)

Solar gains in watts $\Sigma(74)m... (82)m$

40.69	82.82	149.22	245.06	329.41	351.19	328.53	261.91	181.83	101.22	51.20	33.23	(83)
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Total gains - internal and solar $(73)m + (83)m$

385.44	425.70	480.65	558.11	623.96	627.78	593.38	532.12	461.41	399.36	370.67	368.54	(84)
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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	
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Utilisation factor for gains for living area n1,m (see Table 9a)

1.00	1.00	0.99	0.97	0.89	0.74	0.58	0.66	0.89	0.98	1.00	1.00	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.53	19.66	19.94	20.33	20.69	20.91	20.98	20.96	20.77	20.32	19.86	19.51	(87)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

19.82	19.82	19.82	19.83	19.83	19.84	19.84	19.84	19.84	19.83	19.83	19.82	(88)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.99	0.95	0.85	0.64	0.44	0.52	0.83	0.97	0.99	1.00	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

17.87	18.07	18.47	19.04	19.53	19.78	19.83	19.83	19.65	19.04	18.37	17.85	(90)
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Living area fraction

Living area ÷ (4) = 0.31 (91)

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

18.38	18.56	18.92	19.43	19.88	20.13	20.18	20.17	19.99	19.43	18.83	18.36	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.38	18.56	18.92	19.43	19.88	20.13	20.18	20.17	19.99	19.43	18.83	18.36	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, ηm

1.00	0.99	0.98	0.95	0.85	0.67	0.49	0.56	0.84	0.97	0.99	1.00	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

383.73	422.53	472.46	529.19	531.30	419.78	288.17	298.07	387.62	387.25	367.75	367.20	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1185.05	1147.00	1040.59	874.36	678.13	454.18	294.37	309.55	485.64	731.69	975.31	1181.70	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

596.18	486.84	422.69	248.52	109.24	0.00	0.00	0.00	0.00	256.26	437.45	605.99	
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Σ(98)1...5, 10...12 = 3163.17 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) = 50.07 (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
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Space heating fuel (main system 1), kWh/month

637.62	520.69	452.07	265.80	116.84	0.00	0.00	0.00	0.00	274.07	467.86	648.12	
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Σ(211)1...5, 10...12 = 3383.07 (211)

Water heating

Efficiency of water heater

87.96	87.81	87.42	86.45	84.35	79.80	79.80	79.80	79.80	86.43	87.53	88.04	(217)
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Water heating fuel, kWh/month

185.98	163.83	171.96	154.68	154.45	144.50	137.48	152.65	152.95	160.49	169.07	180.94	
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Σ(219a)1...12 = 1928.98 (219)

Annual totals

Space heating fuel - main system 1

3383.07

Water heating fuel		1928.98	
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)		289.21	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	5676.27	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	3383.07	x	3.48	x 0.01 =	117.73	(240)
Water heating	1928.98	x	3.48	x 0.01 =	67.13	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	289.21	x	13.19	x 0.01 =	38.15	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		352.90	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.37	(257)
SAP value	80.89	
SAP rating (section 13)	81	(258)
SAP band	B	

12a. CO₂ 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	3383.07	x	0.216	=	730.74	(261)
Water heating	1928.98	x	0.216	=	416.66	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1147.40	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	289.21	x	0.519	=	150.10	(268)
Total CO ₂ , kg/year			(265)...(271) =		1336.43	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		21.16	(273)
EI value					83.44	
EI rating (section 14)					83	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	3383.07	x	1.22	=	4127.35	(261)
Water heating	1928.98	x	1.22	=	2353.36	(264)
Space and water heating			(261) + (262) + (263) + (264) =		6480.71	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	289.21	x	3.07	=	887.88	(268)
Primary energy kWh/year					7598.84	(272)
Dwelling primary energy rate kWh/m ² /year					120.29	(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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	2B TF Block B x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	63.47 (1a)	x	2.75 (2a)	=	174.54 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 63.47 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 174.54 (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	2	x 10 =	20 (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) = 20	÷ (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, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	5.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.36 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.31 (21)
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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)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.40	0.39	0.38	0.34	0.33	0.29	0.29	0.29	0.31	0.33	0.35	0.36 (22b)
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Calculate effective air change rate for the applicable case:

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

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57 (24d)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.58	0.58	0.57	0.56	0.56	0.54	0.54	0.54	0.55	0.56	0.56	0.57 (25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	x 1.00	= 1.98		(26)						
Window			12.00	x 1.33	= 15.91		(27)						
External wall			64.32	x 0.18	= 11.58		(29a)						
Party wall			19.50	x 0.00	= 0.00		(32)						
Roof			63.47	x 0.13	= 8.25		(30)						
Total area of external elements ΣA, m ²			141.77				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	37.72	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						15.49	(36)						
Total fabric heat loss					(33) + (36) =	53.21	(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)	33.30	33.12	32.95	32.15	32.00	31.30	31.30	31.17	31.57	32.00	32.30	32.62	(38)
Heat transfer coefficient, W/K (37)m + (38)m	86.50	86.33	86.16	85.35	85.20	84.50	84.50	84.37	84.77	85.20	85.51	85.82	
	Average = Σ(39)1...12/12 =											85.35	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.36	1.36	1.36	1.34	1.34	1.33	1.33	1.33	1.34	1.34	1.35	1.35	
	Average = Σ(40)1...12/12 =											1.34	(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	2.08											(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$	83.55											(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
	91.90	88.56	85.22	81.88	78.54	75.19	75.19	78.54	81.88	85.22	88.56	91.90	
	$\Sigma(44)1...12 =$											1002.59	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)													
	136.29	119.20	123.00	107.24	102.90	88.79	82.28	94.42	95.54	111.35	121.55	131.99	
	$\Sigma(45)1...12 =$											1314.55	(45)
Distribution loss $0.15 \times (45)m$													
	20.44	17.88	18.45	16.09	15.43	13.32	12.34	14.16	14.33	16.70	18.23	19.80	
Storage volume (litres) including any solar or WWHRS storage within same vessel												3.00	(47)
Water storage loss:													
a) If manufacturer's declared loss factor is known (kWh/day)												0.26	(48)
Temperature factor from Table 2b												0.54	(49)
Energy lost from water storage (kWh/day) $(48) \times (49)$												0.14	(50)
Enter (50) or (54) in (55)												0.14	(55)
Water storage loss calculated for each month $(55) \times (41)m$													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	
If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)													
	4.36	3.93	4.36	4.21	4.36	4.21	4.36	4.36	4.21	4.36	4.21	4.36	

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 $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

163.91	144.15	150.62	133.97	130.52	115.52	109.90	122.03	122.27	138.97	148.27	159.61
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (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) $(62)m + (63)m$

163.91	144.15	150.62	133.97	130.52	115.52	109.90	122.03	122.27	138.97	148.27	159.61
$\Sigma(64)1...12 =$										1639.73	(64)

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

67.41	59.59	62.99	57.04	56.31	50.91	49.45	53.49	53.15	59.12	61.80	65.98
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (65)

5. Internal gains

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Metabolic gains (Table 5)

103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (66)

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

16.42	14.58	11.86	8.98	6.71	5.67	6.12	7.96	10.68	13.56	15.83	16.87
-------	-------	-------	------	------	------	------	------	-------	-------	-------	-------

 (67)

Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

181.61	183.49	178.74	168.63	155.87	143.88	135.86	133.98	138.73	148.84	161.60	173.59
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (68)

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (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)

-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (71)

Water heating gains (Table 5)

90.61	88.68	84.67	79.22	75.68	70.70	66.47	71.89	73.82	79.46	85.83	88.68
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (72)

Total internal gains $(66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m$

345.80	343.91	332.44	314.00	295.43	277.41	265.62	271.00	280.39	299.02	320.42	336.32
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (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

SouthWest 0.77 x 12.00 x 36.79 x 0.9 x 0.63 x 0.70 = 134.94 (79)

Solar gains in watts $\Sigma(74)m...(82)m$

134.94	229.85	314.49	389.66	436.45	433.30	417.75	382.84	340.52	254.03	161.62	115.48
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (83)

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

480.73	573.76	646.92	703.66	731.89	710.71	683.37	653.83	620.92	553.05	482.04	451.79
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (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	0.99	0.97	0.93	0.85	0.69	0.53	0.57	0.79	0.95	0.99	1.00
------	------	------	------	------	------	------	------	------	------	------	------

 (86)

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

19.62	19.83	20.12	20.46	20.75	20.93	20.98	20.98	20.87	20.48	19.98	19.58	(87)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

19.79	19.79	19.80	19.81	19.81	19.82	19.82	19.82	19.81	19.81	19.80	19.80	(88)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.98	0.96	0.91	0.79	0.59	0.39	0.43	0.70	0.93	0.98	0.99	(89)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

17.99	18.29	18.71	19.20	19.58	19.77	19.81	19.81	19.71	19.24	18.52	17.94	(90)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Living area fraction

Living area ÷ (4) = 0.42 (91)

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

18.68	18.94	19.30	19.73	20.07	20.26	20.30	20.30	20.20	19.76	19.14	18.63	(92)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

18.68	18.94	19.30	19.73	20.07	20.26	20.30	20.30	20.20	19.76	19.14	18.63	(93)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	--

Utilisation factor for gains, ηm

0.99	0.98	0.96	0.91	0.81	0.63	0.45	0.49	0.74	0.93	0.98	0.99	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

476.19	562.33	619.97	639.02	589.74	448.24	307.80	321.39	456.65	511.98	473.05	448.47	(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]

1243.77	1211.70	1102.72	924.40	713.25	478.20	313.02	329.10	517.02	780.69	1029.36	1238.67	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

571.08	436.38	359.16	205.47	91.89	0.00	0.00	0.00	0.00	199.92	400.55	587.91	
--------	--------	--------	--------	-------	------	------	------	------	--------	--------	--------	--

Σ(98)1...5, 10...12 = 2852.35 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 44.94 (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	
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Space heating fuel (main system 1), kWh/month

610.78	466.71	384.13	219.75	98.27	0.00	0.00	0.00	0.00	213.81	428.40	628.78	
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Σ(211)1...5, 10...12 = 3050.65 (211)

Water heating

Efficiency of water heater

87.87	87.58	87.05	85.95	83.90	79.80	79.80	79.80	79.80	85.78	87.34	87.98	(217)
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Water heating fuel, kWh/month

186.53	164.58	173.03	155.86	155.56	144.76	137.72	152.93	153.22	162.00	169.77	181.41	
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Σ(219a)1...12 = 1937.37 (219)

Annual totals

Space heating fuel - main system 1

3050.65

Water heating fuel		1937.37	
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)		289.91	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	5352.92	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	3050.65	x	3.48	x 0.01 =	106.16	(240)
Water heating	1937.37	x	3.48	x 0.01 =	67.42	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	289.91	x	13.19	x 0.01 =	38.24	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		341.71	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.32	(257)
SAP value	81.54	
SAP rating (section 13)	82	(258)
SAP band	B	

12a. CO₂ 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	3050.65	x	0.216	=	658.94	(261)
Water heating	1937.37	x	0.216	=	418.47	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1077.41	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	289.91	x	0.519	=	150.46	(268)
Total CO ₂ , kg/year			(265)...(271) =		1266.80	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		19.96	(273)
EI value					84.35	
EI rating (section 14)					84	(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	3050.65	x	1.22	=	3721.79	(261)
Water heating	1937.37	x	1.22	=	2363.59	(264)
Space and water heating			(261) + (262) + (263) + (264) =		6085.38	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	289.91	x	3.07	=	890.02	(268)
Primary energy kWh/year					7205.64	(272)
Dwelling primary energy rate kWh/m ² /year					113.53	(273)

Appendix C

DER Worksheets for Representative Dwellings

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 Jonathan Peck	Assessor number	10160
Client		Last modified	09/12/2020
Address	1B MF Block B x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	50.32 (1a)	2.75 (2a)	138.38 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 50.32 (4)		
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 138.38 (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	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, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.20 (18)
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Number of sides on which the dwelling is sheltered	3 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.78 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.16 (21)
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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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.20	0.19	0.19	0.17	0.17	0.15	0.15	0.14	0.16	0.17	0.17	0.18
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Calculate effective air change rate for the applicable case:

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

0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	1.00	1.98		(26)						
Window			7.09	1.33	9.40		(27)						
External wall			32.93	0.17	5.60		(29a)						
Party wall			43.20	0.00	0.00		(32)						
Total area of external elements ΣA, m ²			42.00				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	16.98	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						100.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						6.51	(36)						
Total fabric heat loss					(33) + (36) =	23.48	(37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 × (25)m × (5)	22.83	22.83	22.83	22.83	22.83	22.83	22.83	22.83	22.83	22.83	22.83	22.83	(38)
Heat transfer coefficient, W/K (37)m + (38)m	46.32	46.32	46.32	46.32	46.32	46.32	46.32	46.32	46.32	46.32	46.32	46.32	
	Average = Σ(39)1...12/12 =										46.32	(39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	
	Average = Σ(40)1...12/12 =										0.92	(40)	
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N											1.70	(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$											74.56	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
	82.02	79.04	76.06	73.07	70.09	67.11	67.11	70.09	73.07	76.06	79.04	82.02	
											$\Sigma(44)_{1...12} =$	894.76	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)													
	121.63	106.38	109.78	95.71	91.83	79.24	73.43	84.26	85.27	99.37	108.47	117.80	
											$\Sigma(45)_{1...12} =$	1173.18	(45)
Distribution loss $0.15 \times (45)m$													
	18.25	15.96	16.47	14.36	13.77	11.89	11.01	12.64	12.79	14.91	16.27	17.67	(46)
Storage volume (litres) including any solar or WWHRS storage within same vessel											3.00	(47)	
Water storage loss:													
b) Manufacturer's declared loss factor is not known													
Hot water storage loss factor from Table 2 (kWh/litre/day)											0.02	(51)	
Volume factor from Table 2a											3.42	(52)	
Temperature factor from Table 2b											1.00	(53)	
Energy lost from water storage (kWh/day) $(47) \times (51) \times (52) \times (53)$											0.22	(54)	
Enter (50) or (54) in (55)											0.22	(55)	
Water storage loss calculated for each month $(55) \times (41)m$													
	6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)													

6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(57)
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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)
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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 $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

151.63	133.48	139.77	124.74	121.83	108.27	103.43	114.26	114.30	129.37	137.50	147.79	(62)
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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)
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Output from water heater for each month (kWh/month) (62)m + (63)m

151.63	133.48	139.77	124.74	121.83	108.27	103.43	114.26	114.30	129.37	137.50	147.79	
$\Sigma(64)1...12 =$											1526.38	(64)

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

64.44	57.05	60.50	55.05	54.53	49.57	48.41	52.02	51.58	57.04	59.29	63.17	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Metabolic gains (Table 5)

84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	84.98	(66)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

13.75	12.22	9.93	7.52	5.62	4.75	5.13	6.67	8.95	11.36	13.26	14.14	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

148.07	149.60	145.73	137.49	127.08	117.30	110.77	109.23	113.11	121.35	131.75	141.53	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	31.50	(69)
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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)

-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	-67.98	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

86.61	84.89	81.32	76.45	73.30	68.85	65.07	69.91	71.63	76.67	82.35	84.90	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

296.93	295.20	285.47	269.95	254.49	239.39	229.46	234.31	242.18	257.87	275.86	289.06	(73)
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6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
SouthEast	0.77	x 7.09	x 36.79	x 0.9 x 0.45	x 0.80	= 65.08	(77)

Solar gains in watts $\Sigma(74)m...(82)m$

65.08	110.86	151.68	187.94	210.51	208.99	201.48	184.65	164.24	122.52	77.95	55.70	(83)
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Total gains - internal and solar (73)m + (83)m

362.01	406.06	437.15	457.89	465.00	448.38	430.95	418.95	406.42	380.39	353.81	344.76	(84)
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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
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Utilisation factor for gains for living area n1,m (see Table 9a)

0.94	0.92	0.88	0.82	0.72	0.58	0.45	0.47	0.65	0.83	0.92	0.95	(86)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

19.33	19.56	19.90	20.29	20.63	20.86	20.95	20.94	20.79	20.36	19.77	19.26	(87)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	20.15	(88)
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Utilisation factor for gains for rest of dwelling n2,m

0.94	0.91	0.87	0.80	0.68	0.52	0.37	0.40	0.60	0.80	0.91	0.94	(89)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

17.92	18.25	18.72	19.27	19.73	20.02	20.12	20.11	19.94	19.38	18.55	17.81	(90)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Living area fraction

Living area ÷ (4) = 0.49 (91)

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

18.61	18.89	19.30	19.77	20.17	20.43	20.53	20.52	20.36	19.86	19.15	18.52	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.61	18.89	19.30	19.77	20.17	20.43	20.53	20.52	20.36	19.86	19.15	18.52	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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Utilisation factor for gains, ηm

0.92	0.89	0.85	0.79	0.68	0.54	0.40	0.43	0.61	0.79	0.89	0.93	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

332.86	362.25	372.13	359.47	318.03	243.28	173.82	180.56	249.43	301.97	314.68	319.90	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

662.82	648.08	592.81	503.34	392.45	270.14	181.90	190.70	289.92	428.91	557.93	663.40	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

245.49	192.07	164.18	103.58	55.37	0.00	0.00	0.00	0.00	94.44	175.14	255.57	
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Σ(98)1...5, 10...12 = 1285.84 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) = 25.55 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11) '0' if none 0.00 (301)

Fraction of space heat from community system 1 - (301) = 1.00 (302)

Fraction of community heat from heat pump 0.67 (303a)

Fraction of community heat from boilers 0.33 (303b)

Fraction of total space heat from community heat pump (302) x (303a) = 0.67 (304a)

Fraction of total space heat from community boilers (302) x (303b) = 0.33 (304b)

Factor for control and charging method (Table 4c(3)) for community space heating 1.00 (305)

Factor for charging method (Table 4c(3)) for community water heating 1.00 (305a)

Distribution loss factor (Table 12c) for community heating system 1.50 (306)

Space heating

Annual space heating requirement 1285.84 (98)

Space heat from heat pump (98) x (304a) x (305) x (306) = 1292.27 (307a)

Space heat from boilers (98) x (304b) x (305) x (306) = 636.49 (307b)

Water heating

Annual water heating requirement 1526.38 (64)

Water heat from heat pump (64) x (303a) x (305a) x (306) = 1534.01 (310a)

Water heat from boilers	$(64) \times (303b) \times (305a) \times (306) =$	755.56	(310b)
Electricity used for heat distribution	$0.01 \times [(307a)...(307e) + (310a)...(310e)] =$	42.18	(313)
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside		35.12	(330a)
Total electricity for the above, kWh/year		35.12	(331)
Electricity for lighting (Appendix L)		242.90	(332)
Total delivered energy for all uses	$(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =$	4496.35	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	1292.27	x	4.24	x 0.01 =	54.79	(340a)
Space heating from boilers	636.49	x	4.24	x 0.01 =	26.99	(340b)
Water heating from heat pump	1534.01	x	4.24	x 0.01 =	65.04	(342a)
Water heating from boilers	755.56	x	4.24	x 0.01 =	32.04	(342b)
Pumps and fans	35.12	x	13.19	x 0.01 =	4.63	(349)
Electricity for lighting	242.90	x	13.19	x 0.01 =	32.04	(350)
Additional standing charges					120.00	(351)
Total energy cost				$(340a)...(342e) + (345)...(354) =$	335.53	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.48	(357)
SAP value	79.38	
SAP rating (section 13)	79	(358)
SAP band	C	

12b. CO₂ emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of heat pump	280.00					(367a)
CO ₂ emissions from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1009.39	x	0.519	=	523.87	(367)
Efficiency of boilers	89.50					(367b)
CO ₂ emissions from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	1555.36	x	0.216	=	335.96	(368)
Electrical energy for community heat distribution	42.18	x	0.519	=	21.89	(372)
Total CO ₂ associated with community systems					881.72	(373)
Total CO ₂ associated with space and water heating					881.72	(376)
Pumps and fans	35.12	x	0.519	=	18.22	(378)
Electricity for lighting	242.90	x	0.519	=	126.07	(379)
Total CO ₂ , kg/year				$(376)..(382) =$	1026.01	(383)
Dwelling CO ₂ emission rate				$(383) \div (4) =$	20.39	(384)
EI value					85.58	
EI rating (section 14)					86	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year	Primary factor	Primary energy (kWh/year)
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Primary energy from other sources (space heating)

Efficiency of heat pump	280.00					(367a)
Primary energy from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1009.39	x	3.07	=	3098.82	(367)
Efficiency of boilers	89.50					(367b)
Primary energy from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	1555.36	x	1.22	=	1897.54	(368)
Electrical energy for community heat distribution	42.18	x	3.07	=	129.50	(372)
Total primary energy associated with community systems					5125.86	(373)
Total primary energy associated with space and water heating					5125.86	(376)
Pumps and fans	35.12	x	3.07	=	107.80	(378)
Electricity for lighting	242.90	x	3.07	=	745.71	(379)
Primary energy kWh/year					5979.37	(383)
Dwelling primary energy rate kWh/m2/year					118.83	(384)

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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	2B MF Block A x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	70.72 (1a)	2.75 (2a)	194.48 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 70.72 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	194.48 (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	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, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.20 (18)
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Number of sides on which the dwelling is sheltered	3 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.78 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.16 (21)
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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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.20	0.19	0.19	0.17	0.17	0.15	0.15	0.14	0.16	0.17	0.17	0.18
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Calculate effective air change rate for the applicable case:

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

0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	x 1.00	= 1.98		(26)						
Window			9.12	x 1.33	= 12.09		(27)						
External wall			49.80	x 0.17	= 8.47		(29a)						
Party wall			41.40	x 0.00	= 0.00		(32)						
Total area of external elements ΣA, m ²			60.90				(31)						
Fabric heat loss, W/K = Σ(A × U)						(26)...(30) + (32) =	22.54 (33)						
Heat capacity Cm = Σ(A × κ)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)						
Thermal mass parameter (TMP) in kJ/m ² K							100.00 (35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K							8.55 (36)						
Total fabric heat loss						(33) + (36) =	31.09 (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)	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	(38)
Heat transfer coefficient, W/K (37)m + (38)m	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	
	Average = Σ(39)1...12/12 =										63.18	(39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	
	Average = Σ(40)1...12/12 =										0.89	(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											2.26	(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$											87.96	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$													
	96.75	93.24	89.72	86.20	82.68	79.16	79.16	82.68	86.20	89.72	93.24	96.75	
											$\Sigma(44)1...12 =$	1055.49	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)													
	143.48	125.49	129.50	112.90	108.33	93.48	86.62	99.40	100.59	117.22	127.96	138.96	
											$\Sigma(45)1...12 =$	1383.92	(45)
Distribution loss $0.15 \times (45)m$													
	21.52	18.82	19.42	16.93	16.25	14.02	12.99	14.91	15.09	17.58	19.19	20.84	
Storage volume (litres) including any solar or WWHRS storage within same vessel											3.00	(47)	
Water storage loss:													
b) Manufacturer's declared loss factor is not known													
Hot water storage loss factor from Table 2 (kWh/litre/day)											0.02	(51)	
Volume factor from Table 2a											3.42	(52)	
Temperature factor from Table 2b											1.00	(53)	
Energy lost from water storage (kWh/day) $(47) \times (51) \times (52) \times (53)$											0.22	(54)	
Enter (50) or (54) in (55)											0.22	(55)	
Water storage loss calculated for each month $(55) \times (41)m$													
	6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	
If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)													

6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(57)
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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)
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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)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

173.48	152.59	159.49	141.93	138.33	122.51	116.62	129.40	129.62	147.22	156.99	168.95	(62)
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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)
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Output from water heater for each month (kWh/month) (62)m + (63)m

173.48	152.59	159.49	141.93	138.33	122.51	116.62	129.40	129.62	147.22	156.99	168.95	
$\Sigma(64)1...12 =$											1737.11	(64)

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

71.71	63.40	67.06	60.76	60.02	54.31	52.80	57.05	56.67	62.98	65.77	70.20	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Metabolic gains (Table 5)

113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	(66)
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

18.82	16.72	13.59	10.29	7.69	6.50	7.02	9.12	12.24	15.55	18.15	19.34	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

198.97	201.04	195.83	184.76	170.77	157.63	148.85	146.79	151.99	163.07	177.05	190.19	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	(69)
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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)

-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	(71)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Water heating gains (Table 5)

96.38	94.35	90.13	84.39	80.67	75.42	70.97	76.68	78.71	84.64	91.35	94.36	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

371.12	369.05	356.51	336.39	316.09	296.51	283.79	289.54	299.90	320.21	343.50	360.84	(73)
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6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
NorthWest	0.77	x 9.12	x 11.28	x 0.9 x 0.45	x 0.80	= 25.67	(81)

Solar gains in watts $\Sigma(74)m...(82)m$

25.67	52.26	94.15	154.62	207.84	221.57	207.28	165.24	114.72	63.86	32.30	20.96	(83)
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Total gains - internal and solar (73)m + (83)m

396.80	421.31	450.66	491.01	523.92	518.08	491.07	454.79	414.62	384.07	375.80	381.81	(84)
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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)

0.97	0.96	0.94	0.89	0.80	0.65	0.52	0.57	0.77	0.91	0.96	0.97	(86)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

19.14	19.30	19.63	20.09	20.53	20.82	20.94	20.91	20.68	20.15	19.56	19.09	(87)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	(88)
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Utilisation factor for gains for rest of dwelling n2,m

0.96	0.95	0.93	0.87	0.76	0.60	0.44	0.49	0.72	0.89	0.95	0.97	(89)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

17.65	17.89	18.37	19.02	19.62	20.00	20.13	20.10	19.83	19.11	18.27	17.58	(90)
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Living area fraction

Living area ÷ (4) = 0.48 (91)

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

18.37	18.57	18.98	19.54	20.06	20.39	20.52	20.49	20.24	19.61	18.89	18.30	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.37	18.57	18.98	19.54	20.06	20.39	20.52	20.49	20.24	19.61	18.89	18.30	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, ηm

0.95	0.94	0.91	0.86	0.76	0.61	0.47	0.52	0.73	0.88	0.94	0.96	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

377.66	396.18	412.08	421.14	396.84	317.24	231.51	236.78	302.25	337.38	351.57	365.14	(95)
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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]

888.98	863.59	788.35	672.10	528.07	366.02	247.42	258.68	388.07	569.24	745.00	891.08	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

380.42	314.10	279.95	180.69	97.63	0.00	0.00	0.00	0.00	172.50	283.27	391.30	
										Σ(98)1...5, 10...12 =	2099.87	(98)

Space heating requirement kWh/m²/year

(98) ÷ (4) 29.69 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)

'0' if none 0.00 (301)

Fraction of space heat from community system

1 - (301) = 1.00 (302)

Fraction of community heat from heat pump

0.67 (303a)

Fraction of community heat from boilers

0.33 (303b)

Fraction of total space heat from community heat pump

(302) x (303a) = 0.67 (304a)

Fraction of total space heat from community boilers

(302) x (303b) = 0.33 (304b)

Factor for control and charging method (Table 4c(3)) for community space heating

1.00 (305)

Factor for charging method (Table 4c(3)) for community water heating

1.00 (305a)

Distribution loss factor (Table 12c) for community heating system

1.50 (306)

Space heating

Annual space heating requirement

2099.87 (98)

Space heat from heat pump

(98) x (304a) x (305) x (306) = 2110.37 (307a)

Space heat from boilers

(98) x (304b) x (305) x (306) = 1039.44 (307b)

Water heating

Annual water heating requirement

1737.11 (64)

Water heat from heat pump

(64) x (303a) x (305a) x (306) = 1745.80 (310a)

Water heat from boilers	$(64) \times (303b) \times (305a) \times (306) =$	859.87	(310b)
Electricity used for heat distribution	$0.01 \times [(307a)...(307e) + (310a)...(310e)] =$	57.55	(313)
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside		49.35	(330a)
Total electricity for the above, kWh/year		49.35	(331)
Electricity for lighting (Appendix L)		332.38	(332)
Total delivered energy for all uses	$(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =$	6137.22	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	2110.37	x	4.24	x 0.01 =	89.48	(340a)
Space heating from boilers	1039.44	x	4.24	x 0.01 =	44.07	(340b)
Water heating from heat pump	1745.80	x	4.24	x 0.01 =	74.02	(342a)
Water heating from boilers	859.87	x	4.24	x 0.01 =	36.46	(342b)
Pumps and fans	49.35	x	13.19	x 0.01 =	6.51	(349)
Electricity for lighting	332.38	x	13.19	x 0.01 =	43.84	(350)
Additional standing charges					120.00	(351)
Total energy cost				$(340a)...(342e) + (345)...(354) =$	414.38	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.50	(357)
SAP value	79.02	
SAP rating (section 13)	79	(358)
SAP band	C	

12b. CO₂ emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of heat pump	280.00					(367a)
CO ₂ emissions from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1377.20	x	0.519	=	714.77	(367)
Efficiency of boilers	89.50					(367b)
CO ₂ emissions from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	2122.13	x	0.216	=	458.38	(368)
Electrical energy for community heat distribution	57.55	x	0.519	=	29.87	(372)
Total CO ₂ associated with community systems					1203.02	(373)
Total CO ₂ associated with space and water heating					1203.02	(376)
Pumps and fans	49.35	x	0.519	=	25.61	(378)
Electricity for lighting	332.38	x	0.519	=	172.51	(379)
Total CO ₂ , kg/year				$(376)..(382) =$	1401.14	(383)
Dwelling CO ₂ emission rate				$(383) \div (4) =$	19.81	(384)
EI value					83.78	
EI rating (section 14)					84	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year	Primary factor	Primary energy (kWh/year)
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Primary energy from other sources (space heating)

Efficiency of heat pump	280.00					(367a)
Primary energy from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1377.20	x	3.07	=	4228.02	(367)
Efficiency of boilers	89.50					(367b)
Primary energy from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	2122.13	x	1.22	=	2589.00	(368)
Electrical energy for community heat distribution	57.55	x	3.07	=	176.69	(372)
Total primary energy associated with community systems					6993.71	(373)
Total primary energy associated with space and water heating					6993.71	(376)
Pumps and fans	49.35	x	3.07	=	151.51	(378)
Electricity for lighting	332.38	x	3.07	=	1020.42	(379)
Primary energy kWh/year					8165.64	(383)
Dwelling primary energy rate kWh/m ² /year					115.46	(384)

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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	1B Terrace Block E x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	50.66 (1a)	2.75 (2a)	139.32 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 50.66 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) = 139.32 (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	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, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.20 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.17 (21)
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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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.20
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50 (23a)
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If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	77.35 (23c)
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a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]

0.33	0.33	0.32	0.30	0.30	0.27	0.27	0.27	0.28	0.30	0.30	0.31
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.33	0.33	0.32	0.30	0.30	0.27	0.27	0.27	0.28	0.30	0.30	0.31
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	x	1.00	=	1.98	(26)					
Window			10.56	x	1.33	=	14.00	(27)					
External wall			49.56	x	0.17	=	8.43	(29a)					
Party wall			24.00	x	0.00	=	0.00	(32)					
Roof			14.36	x	0.15	=	2.15	(30)					
Total area of external elements ΣA, m ²			76.46					(31)					
Fabric heat loss, W/K = Σ(A × U)						(26)...(30) + (32) =	26.56	(33)					
Heat capacity Cm = Σ(A × κ)						(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)					
Thermal mass parameter (TMP) in kJ/m ² K							100.00	(35)					
Thermal bridges: Σ(L × Ψ) calculated using Appendix K							11.79	(36)					
Total fabric heat loss						(33) + (36) =	38.35	(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)	15.17	14.98	14.78	13.80	13.61	12.63	12.63	12.44	13.02	13.61	14.00	14.39	(38)
Heat transfer coefficient, W/K (37)m + (38)m	53.52	53.33	53.13	52.15	51.96	50.98	50.98	50.79	51.37	51.96	52.35	52.74	
	Average = Σ(39)1...12/12 =											52.10	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.06	1.05	1.05	1.03	1.03	1.01	1.01	1.00	1.01	1.03	1.03	1.04	
	Average = Σ(40)1...12/12 =											1.03	(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

Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$

1.71	(42)
74.80	(43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Hot water usage in litres per day for each month $V_{d,m}$ = factor from Table 1c x (43)

82.28	79.29	76.30	73.31	70.31	67.32	67.32	70.31	73.31	76.30	79.29	82.28
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$\sum(44)1...12 =$ 897.62 (44)

Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)

122.02	106.72	110.13	96.01	92.12	79.50	73.67	84.53	85.54	99.69	108.82	118.17
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$\sum(45)1...12 =$ 1176.92 (45)

Distribution loss $0.15 \times (45)m$

18.30	16.01	16.52	14.40	13.82	11.92	11.05	12.68	12.83	14.95	16.32	17.73
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(46)

Storage volume (litres) including any solar or WWHRS storage within same vessel

3.00 (47)

Water storage loss:

b) Manufacturer's declared loss factor is not known

Hot water storage loss factor from Table 2 (kWh/litre/day)

0.02 (51)

Volume factor from Table 2a

3.42 (52)

Temperature factor from Table 2b

1.00 (53)

Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53)

0.22 (54)

Enter (50) or (54) in (55)

0.22 (55)

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

6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74
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(56)

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

6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(57)
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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)
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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)
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Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

152.02	133.82	140.12	125.04	122.12	108.53	103.66	114.53	114.57	129.69	137.85	148.17	(62)
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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)
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Output from water heater for each month (kWh/month) (62)m + (63)m

152.02	133.82	140.12	125.04	122.12	108.53	103.66	114.53	114.57	129.69	137.85	148.17	
Σ(64)1...12 =											1530.12	(64)

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

64.57	57.16	60.62	55.15	54.63	49.66	48.49	52.11	51.67	57.15	59.41	63.29	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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Metabolic gains (Table 5)

85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48	85.48	(66)
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

13.28	11.79	9.59	7.26	5.43	4.58	4.95	6.44	8.64	10.97	12.80	13.65	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

148.95	150.49	146.60	138.31	127.84	118.00	111.43	109.89	113.78	122.07	132.54	142.38	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	31.55	(69)
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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)
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Losses e.g. evaporation (Table 5)

-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	(71)
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Water heating gains (Table 5)

86.79	85.06	81.47	76.59	73.43	68.97	65.18	70.03	71.76	76.81	82.51	85.07	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

297.66	295.99	286.31	270.81	255.34	240.20	230.20	235.00	242.82	258.49	276.49	289.73	(73)
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6. Solar gains

	Access factor Table 6d	Area m²	Solar flux W/m²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
SouthWest	0.77	x 6.72	x 36.79	x 0.9 x 0.45	x 0.80	= 61.69	(79)
NorthWest	0.77	x 3.84	x 11.28	x 0.9 x 0.45	x 0.80	= 10.81	(81)

Solar gains in watts Σ(74)m...(82)m

72.49	127.07	183.41	243.23	287.03	291.37	278.24	244.59	203.97	143.02	87.49	61.62	(83)
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Total gains - internal and solar (73)m + (83)m

370.15	423.07	469.71	514.04	542.37	531.57	508.45	479.59	446.79	401.51	363.98	351.35	(84)
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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)

0.95	0.92	0.88	0.81	0.69	0.54	0.42	0.45	0.65	0.84	0.92	0.95	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.02	19.29	19.70	20.20	20.61	20.86	20.95	20.94	20.76	20.24	19.56	18.98	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.04	20.04	20.04	20.06	20.06	20.08	20.08	20.08	20.07	20.06	20.06	20.05	(88)
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Utilisation factor for gains for rest of dwelling n2,m

0.94	0.91	0.87	0.78	0.65	0.48	0.34	0.37	0.59	0.81	0.91	0.95	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

17.40	17.79	18.37	19.08	19.62	19.95	20.05	20.04	19.84	19.16	18.19	17.35	(90)
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Living area fraction

Living area ÷ (4) = 0.62 (91)

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

18.40	18.72	19.19	19.78	20.23	20.52	20.61	20.60	20.41	19.83	19.04	18.36	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.40	18.72	19.19	19.78	20.23	20.52	20.61	20.60	20.41	19.83	19.04	18.36	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, ηm

0.92	0.89	0.85	0.77	0.66	0.51	0.38	0.42	0.61	0.80	0.89	0.93	(94)
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Useful gains, ηmGm, W (94)m x (84)m

341.66	378.58	399.25	396.83	357.51	272.19	194.89	200.83	273.32	320.74	325.42	327.05	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

754.82	736.99	674.49	567.41	443.33	301.63	204.36	213.14	324.13	479.66	624.99	746.78	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

307.39	240.85	204.78	122.81	63.85	0.00	0.00	0.00	0.00	118.23	215.69	312.27	
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Σ(98)1...5, 10...12 = 1585.89 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) = 31.30 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)

'0' if none 0.00 (301)

Fraction of space heat from community system

1 - (301) = 1.00 (302)

Fraction of community heat from heat pump

0.67 (303a)

Fraction of community heat from boilers

0.33 (303b)

Fraction of total space heat from community heat pump

(302) x (303a) = 0.67 (304a)

Fraction of total space heat from community boilers

(302) x (303b) = 0.33 (304b)

Factor for control and charging method (Table 4c(3)) for community space heating

1.00 (305)

Factor for charging method (Table 4c(3)) for community water heating

1.00 (305a)

Distribution loss factor (Table 12c) for community heating system

1.50 (306)

Space heating

Annual space heating requirement

1585.89 (98)

Space heat from heat pump

(98) x (304a) x (305) x (306) = 1593.82 (307a)

Space heat from boilers

(98) x (304b) x (305) x (306) = 785.01 (307b)

Water heating

Annual water heating requirement	1530.12	(64)
Water heat from heat pump	$(64) \times (303a) \times (305a) \times (306) =$	1537.77 (310a)
Water heat from boilers	$(64) \times (303b) \times (305a) \times (306) =$	757.41 (310b)
Electricity used for heat distribution	$0.01 \times [(307a)...(307e) + (310a)...(310e)] =$	46.74 (313)
Electricity for pumps, fans and electric keep-hot (Table 4f)		
mechanical ventilation fans - balanced, extract or positive input from outside	89.23	(330a)
Total electricity for the above, kWh/year		89.23 (331)
Electricity for lighting (Appendix L)		234.51 (332)
Total delivered energy for all uses	$(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =$	4997.75 (338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	1593.82	x	4.24	x 0.01 =	67.58	(340a)
Space heating from boilers	785.01	x	4.24	x 0.01 =	33.28	(340b)
Water heating from heat pump	1537.77	x	4.24	x 0.01 =	65.20	(342a)
Water heating from boilers	757.41	x	4.24	x 0.01 =	32.11	(342b)
Pumps and fans	89.23	x	13.19	x 0.01 =	11.77	(349)
Electricity for lighting	234.51	x	13.19	x 0.01 =	30.93	(350)
Additional standing charges					120.00	(351)
Total energy cost				$(340a)...(342e) + (345)...(354) =$	360.88	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.58	(357)
SAP value	77.90	
SAP rating (section 13)	78	(358)
SAP band	C	

12b. CO₂ emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of heat pump	280.00					(367a)
CO ₂ emissions from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1118.42	x	0.519	=	580.46	(367)
Efficiency of boilers	89.50					(367b)
CO ₂ emissions from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	1723.38	x	0.216	=	372.25	(368)
Electrical energy for community heat distribution	46.74	x	0.519	=	24.26	(372)
Total CO ₂ associated with community systems					976.97	(373)
Total CO ₂ associated with space and water heating					976.97	(376)
Pumps and fans	89.23	x	0.519	=	46.31	(378)
Electricity for lighting	234.51	x	0.519	=	121.71	(379)
Total CO ₂ , kg/year				$(376) \div (382) =$	1144.99	(383)
Dwelling CO ₂ emission rate				$(383) \div (4) =$	22.60	(384)
EI value					83.96	
EI rating (section 14)					84	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)
Primary energy from other sources (space heating)					
Efficiency of heat pump	280.00				(367a)
Primary energy from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1118.42	x	3.07	=	3433.56 (367)
Efficiency of boilers	89.50				(367b)
Primary energy from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	1723.38	x	1.22	=	2102.52 (368)
Electrical energy for community heat distribution	46.74	x	3.07	=	143.49 (372)
Total primary energy associated with community systems					5679.58 (373)
Total primary energy associated with space and water heating					5679.58 (376)
Pumps and fans	89.23	x	3.07	=	273.94 (378)
Electricity for lighting	234.51	x	3.07	=	719.94 (379)
Primary energy kWh/year					6673.46 (383)
Dwelling primary energy rate kWh/m2/year					131.73 (384)

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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	2B Exposed Block D x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	66.09 (1a)	x	2.75 (2a)	=	181.75 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 66.09 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 181.75 (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	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)
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If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.20 (18)
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Number of sides on which the dwelling is sheltered	3 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.78 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.16 (21)
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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)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.20	0.19	0.19	0.17	0.17	0.15	0.15	0.14	0.16	0.17	0.17	0.18 (22b)
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50 (23a)
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If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	77.35 (23c)
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a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]

0.31	0.31	0.30	0.28	0.28	0.26	0.26	0.26	0.27	0.28	0.29	0.30 (24a)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.31	0.31	0.30	0.28	0.28	0.26	0.26	0.26	0.27	0.28	0.29	0.30 (25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	x 1.00	= 1.98		(26)						
Window			8.16	x 1.33	= 10.82		(27)						
Exposed floor			66.09	x 0.15	= 9.91		(28b)						
External wall			56.46	x 0.17	= 9.60		(29a)						
Party wall			32.40	x 0.00	= 0.00		(32)						
Total area of external elements ΣA, m ²			132.69				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	32.31	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						100.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						12.30	(36)						
Total fabric heat loss					(33) + (36) =	44.61	(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)	18.65	18.41	18.18	17.02	16.79	15.62	15.62	15.39	16.09	16.79	17.25	17.72	(38)
Heat transfer coefficient, W/K (37)m + (38)m	63.26	63.02	62.79	61.63	61.40	60.23	60.23	60.00	60.70	61.40	61.86	62.33	
	Average = Σ(39)1...12/12 =											61.57	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.96	0.95	0.95	0.93	0.93	0.91	0.91	0.91	0.92	0.93	0.94	0.94	
	Average = Σ(40)1...12/12 =											0.93	(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												2.15	(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$												85.21	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$														
	93.73	90.32	86.91	83.50	80.09	76.68	76.68	80.09	83.50	86.91	90.32	93.73		
												$\Sigma(44)1...12 =$	1022.46	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)														
	138.99	121.56	125.44	109.36	104.94	90.55	83.91	96.29	97.44	113.56	123.96	134.61		
												$\Sigma(45)1...12 =$	1340.61	(45)
Distribution loss $0.15 \times (45)m$														
	20.85	18.23	18.82	16.40	15.74	13.58	12.59	14.44	14.62	17.03	18.59	20.19	(46)	
Storage volume (litres) including any solar or WWHRS storage within same vessel												3.00	(47)	
Water storage loss:														
b) Manufacturer's declared loss factor is not known														
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.02	(51)	
Volume factor from Table 2a												3.42	(52)	
Temperature factor from Table 2b												1.00	(53)	
Energy lost from water storage (kWh/day) $(47) \times (51) \times (52) \times (53)$												0.22	(54)	
Enter (50) or (54) in (55)												0.22	(55)	
Water storage loss calculated for each month $(55) \times (41)m$														
	6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(56)	

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

6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(57)
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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)
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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)
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Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

168.99	148.66	155.44	138.39	134.94	119.58	113.91	126.29	126.47	143.55	152.99	164.60	(62)
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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)
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Output from water heater for each month (kWh/month) (62)m + (63)m

168.99	148.66	155.44	138.39	134.94	119.58	113.91	126.29	126.47	143.55	152.99	164.60	
$\Sigma(64)1...12 =$											1693.81	(64)

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

70.21	62.10	65.71	59.59	58.89	53.33	51.90	56.01	55.62	61.76	64.44	68.76	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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Metabolic gains (Table 5)

107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38	107.38	(66)
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

17.95	15.94	12.97	9.82	7.34	6.19	6.69	8.70	11.68	14.83	17.31	18.45	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

188.01	189.96	185.04	174.57	161.36	148.95	140.65	138.70	143.62	154.08	167.29	179.71	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74	33.74	(69)
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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)
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Losses e.g. evaporation (Table 5)

-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	-85.90	(71)
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Water heating gains (Table 5)

94.37	92.40	88.32	82.76	79.15	74.07	69.76	75.29	77.25	83.00	89.50	92.41	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

355.54	353.52	341.54	322.36	303.07	284.43	272.31	277.90	287.76	307.13	329.31	345.79	(73)
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6. Solar gains

	Access factor Table 6d		Area m ²		Solar flux W/m ²		g specific data or Table 6b		FF specific data or Table 6c		Gains W	
SouthEast	0.77	x	8.16	x	36.79	x 0.9 x	0.45	x	0.80	=	74.90	(77)

Solar gains in watts $\Sigma(74)m...(82)m$

74.90	127.59	174.57	216.30	242.28	240.52	231.89	212.51	189.02	141.01	89.72	64.10	(83)
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Total gains - internal and solar (73)m + (83)m

430.45	481.11	516.11	538.67	545.34	524.95	504.21	490.42	476.78	448.14	419.03	409.89	(84)
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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)	21.00	(85)
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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Utilisation factor for gains for living area n1,m (see Table 9a)

0.96	0.94	0.91	0.86	0.77	0.63	0.49	0.52	0.70	0.86	0.94	0.96	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.13	19.37	19.72	20.17	20.55	20.83	20.94	20.93	20.75	20.26	19.63	19.10	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.12	20.12	20.13	20.14	20.14	20.16	20.16	20.16	20.15	20.14	20.14	20.13	(88)
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Utilisation factor for gains for rest of dwelling n2,m

0.95	0.93	0.90	0.83	0.73	0.57	0.41	0.44	0.65	0.84	0.93	0.96	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

17.61	17.95	18.45	19.10	19.63	20.00	20.12	20.11	19.90	19.24	18.35	17.57	(90)
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Living area fraction

Living area ÷ (4) = 0.43 (91)

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

18.26	18.55	18.99	19.56	20.02	20.36	20.47	20.46	20.26	19.68	18.90	18.22	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.26	18.55	18.99	19.56	20.02	20.36	20.47	20.46	20.26	19.68	18.90	18.22	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, ηm

0.93	0.91	0.88	0.82	0.72	0.58	0.44	0.47	0.65	0.82	0.91	0.94	(94)
------	------	------	------	------	------	------	------	------	------	------	------	------

Useful gains, ηmGm, W (94)m x (84)m

401.99	438.45	452.61	440.53	395.22	305.48	220.47	228.10	311.79	369.56	380.63	385.60	(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]

883.09	860.53	784.57	656.67	511.02	346.68	233.12	243.64	374.04	557.49	729.86	873.95	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

357.94	283.63	246.98	155.62	86.15	0.00	0.00	0.00	0.00	139.82	251.44	363.33	
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Σ(98)1...5, 10...12 = 1884.92 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) = 28.52 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)

'0' if none 0.00 (301)

Fraction of space heat from community system

1 - (301) = 1.00 (302)

Fraction of community heat from heat pump

0.67 (303a)

Fraction of community heat from boilers

0.33 (303b)

Fraction of total space heat from community heat pump

(302) x (303a) = 0.67 (304a)

Fraction of total space heat from community boilers

(302) x (303b) = 0.33 (304b)

Factor for control and charging method (Table 4c(3)) for community space heating

1.00 (305)

Factor for charging method (Table 4c(3)) for community water heating

1.00 (305a)

Distribution loss factor (Table 12c) for community heating system

1.50 (306)

Space heating

Annual space heating requirement

1884.92 (98)

Space heat from heat pump

(98) x (304a) x (305) x (306) = 1894.34 (307a)

Space heat from boilers

(98) x (304b) x (305) x (306) = 933.04 (307b)

Water heating

Annual water heating requirement

1693.81 (64)

Water heat from heat pump	$(64) \times (303a) \times (305a) \times (306) =$	1702.28	(310a)
Water heat from boilers	$(64) \times (303b) \times (305a) \times (306) =$	838.44	(310b)
Electricity used for heat distribution	$0.01 \times [(307a)...(307e) + (310a)...(310e)] =$	53.68	(313)
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside		138.58	(330a)
Total electricity for the above, kWh/year		138.58	(331)
Electricity for lighting (Appendix L)		317.01	(332)
Total delivered energy for all uses	$(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =$	5823.69	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	1894.34	x	4.24	x 0.01 =	80.32	(340a)
Space heating from boilers	933.04	x	4.24	x 0.01 =	39.56	(340b)
Water heating from heat pump	1702.28	x	4.24	x 0.01 =	72.18	(342a)
Water heating from boilers	838.44	x	4.24	x 0.01 =	35.55	(342b)
Pumps and fans	138.58	x	13.19	x 0.01 =	18.28	(349)
Electricity for lighting	317.01	x	13.19	x 0.01 =	41.81	(350)
Additional standing charges					120.00	(351)
Total energy cost				$(340a)...(342e) + (345)...(354) =$	407.70	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.54	(357)
SAP value	78.50	
SAP rating (section 13)	78	(358)
SAP band	C	

12b. CO₂ emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of heat pump	280.00					(367a)
CO ₂ emissions from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1284.51	x	0.519	=	666.66	(367)
Efficiency of boilers	89.50					(367b)
CO ₂ emissions from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	1979.30	x	0.216	=	427.53	(368)
Electrical energy for community heat distribution	53.68	x	0.519	=	27.86	(372)
Total CO ₂ associated with community systems					1122.05	(373)
Total CO ₂ associated with space and water heating					1122.05	(376)
Pumps and fans	138.58	x	0.519	=	71.92	(378)
Electricity for lighting	317.01	x	0.519	=	164.53	(379)
Total CO ₂ , kg/year				$(376)...(382) =$	1358.50	(383)
Dwelling CO ₂ emission rate				$(383) \div (4) =$	20.56	(384)
EI value					83.61	
EI rating (section 14)					84	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)
Primary energy from other sources (space heating)					
Efficiency of heat pump	280.00				(367a)
Primary energy from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1284.51	x	3.07	=	3943.44 (367)
Efficiency of boilers	89.50				(367b)
Primary energy from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	1979.30	x	1.22	=	2414.74 (368)
Electrical energy for community heat distribution	53.68	x	3.07	=	164.80 (372)
Total primary energy associated with community systems					6522.99 (373)
Total primary energy associated with space and water heating					6522.99 (376)
Pumps and fans	138.58	x	3.07	=	425.45 (378)
Electricity for lighting	317.01	x	3.07	=	973.23 (379)
Primary energy kWh/year					7921.66 (383)
Dwelling primary energy rate kWh/m ² /year					119.86 (384)

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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	2B GF Block C x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	63.17 (1a)	2.75 (2a)	173.72 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 63.17 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) = 173.72 (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	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, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.20 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.17 (21)
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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

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
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.20
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50 (23a)
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If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	77.35 (23c)
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a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]

0.33	0.33	0.32	0.30	0.30	0.27	0.27	0.27	0.28	0.30	0.30	0.31
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.33	0.33	0.32	0.30	0.30	0.27	0.27	0.27	0.28	0.30	0.30	0.31
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	1.00	1.98		(26)						
Window			11.80	1.33	15.64		(27)						
Ground floor			63.17	0.10	6.32		(28a)						
External wall			82.52	0.17	14.03		(29a)						
Total area of external elements ΣA, m ²			159.47				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	37.97	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						100.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						13.02	(36)						
Total fabric heat loss					(33) + (36) =	50.99	(37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 × (25)m × (5)	18.92	18.67	18.43	17.21	16.97	15.75	15.75	15.51	16.24	16.97	17.46	17.94	(38)
Heat transfer coefficient, W/K (37)m + (38)m	69.91	69.67	69.42	68.20	67.96	66.74	66.74	66.50	67.23	67.96	68.45	68.93	
	Average = Σ(39)1...12/12 =										68.14	(39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.11	1.10	1.10	1.08	1.08	1.06	1.06	1.05	1.06	1.08	1.08	1.09	
	Average = Σ(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												2.07	(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$												83.36	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$														
	91.69	88.36	85.02	81.69	78.35	75.02	75.02	78.35	81.69	85.02	88.36	91.69		
												$\sum(44)_{1...12} =$	1000.26	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)														
	135.97	118.92	122.72	106.99	102.66	88.59	82.09	94.20	95.32	111.09	121.26	131.68		
												$\sum(45)_{1...12} =$	1311.50	(45)
Distribution loss $0.15 \times (45)m$														
	20.40	17.84	18.41	16.05	15.40	13.29	12.31	14.13	14.30	16.66	18.19	19.75	(46)	
Storage volume (litres) including any solar or WWHRS storage within same vessel												3.00	(47)	
Water storage loss:														
b) Manufacturer's declared loss factor is not known														
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.02	(51)	
Volume factor from Table 2a												3.42	(52)	
Temperature factor from Table 2b												1.00	(53)	
Energy lost from water storage (kWh/day) $(47) \times (51) \times (52) \times (53)$												0.22	(54)	
Enter (50) or (54) in (55)												0.22	(55)	
Water storage loss calculated for each month $(55) \times (41)m$														
	6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)														

6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(57)
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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)
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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)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

165.97	146.02	152.72	136.02	132.66	117.62	112.09	124.20	124.35	141.09	150.29	161.68	(62)
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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

165.97	146.02	152.72	136.02	132.66	117.62	112.09	124.20	124.35	141.09	150.29	161.68	
$\Sigma(64)1...12 =$											1664.70	(64)

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

69.21	61.22	64.80	58.80	58.13	52.68	51.29	55.32	54.92	60.94	63.54	67.78	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Metabolic gains (Table 5)

103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	103.48	(66)
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

16.15	14.35	11.67	8.83	6.60	5.57	6.02	7.83	10.51	13.34	15.57	16.60	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

180.87	182.74	178.01	167.94	155.23	143.29	135.31	133.43	138.16	148.23	160.94	172.88	(68)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	33.35	(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)

-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	-82.79	(71)
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Water heating gains (Table 5)

93.02	91.10	87.10	81.66	78.13	73.17	68.94	74.35	76.28	81.90	88.26	91.11	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

344.09	342.23	330.82	312.49	294.02	276.07	264.32	269.66	278.99	297.52	318.81	334.64	(73)
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6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
NorthWest	0.77	x 5.22	x 11.28	x 0.9 x 0.45	x 0.80	= 14.69	(81)
NorthEast	0.77	x 6.58	x 11.28	x 0.9 x 0.45	x 0.80	= 18.52	(75)

Solar gains in watts $\Sigma(74)m...(82)m$

33.22	67.61	121.81	200.05	268.91	286.69	268.19	213.80	148.43	82.63	41.79	27.13	(83)
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Total gains - internal and solar (73)m + (83)m

377.30	409.84	452.64	512.54	562.93	562.76	532.51	483.46	427.42	380.15	360.61	361.76	(84)
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7. Mean internal temperature (heating season)

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains for living area n1,m (see Table 9a)

0.97	0.96	0.93	0.87	0.77	0.63	0.50	0.55	0.76	0.91	0.95	0.97	(86)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

18.69	18.90	19.32	19.91	20.43	20.78	20.92	20.89	20.60	19.95	19.24	18.67	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.00	20.00	20.00	20.02	20.02	20.04	20.04	20.04	20.03	20.02	20.01	20.01	(88)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Utilisation factor for gains for rest of dwelling n2,m

0.96	0.95	0.92	0.85	0.73	0.56	0.41	0.46	0.71	0.89	0.95	0.97	(89)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

16.91	17.21	17.81	18.66	19.37	19.83	19.98	19.96	19.62	18.73	17.71	16.88	(90)
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Living area fraction

Living area ÷ (4) = 0.31 (91)

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

17.45	17.73	18.27	19.04	19.69	20.12	20.27	20.24	19.92	19.10	18.18	17.43	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

17.45	17.73	18.27	19.04	19.69	20.12	20.27	20.24	19.92	19.10	18.18	17.43	(93)
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8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Utilisation factor for gains, ηm

0.94	0.93	0.90	0.83	0.72	0.57	0.43	0.48	0.70	0.86	0.93	0.95	(94)
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Useful gains, ηmGm, W (94)m x (84)m

355.93	380.70	406.01	424.93	404.27	318.74	228.24	232.65	298.90	327.43	333.66	343.11	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

919.58	893.56	817.07	691.55	543.27	368.61	244.67	255.45	391.10	577.80	758.44	911.70	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

419.35	344.65	305.83	191.97	103.42	0.00	0.00	0.00	0.00	186.28	305.85	423.03	
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Σ(98)1...5, 10...12 = 2280.37 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) = 36.10 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)

'0' if none 0.00 (301)

Fraction of space heat from community system

1 - (301) = 1.00 (302)

Fraction of community heat from heat pump

0.67 (303a)

Fraction of community heat from boilers

0.33 (303b)

Fraction of total space heat from community heat pump

(302) x (303a) = 0.67 (304a)

Fraction of total space heat from community boilers

(302) x (303b) = 0.33 (304b)

Factor for control and charging method (Table 4c(3)) for community space heating

1.00 (305)

Factor for charging method (Table 4c(3)) for community water heating

1.00 (305a)

Distribution loss factor (Table 12c) for community heating system

1.50 (306)

Space heating

Annual space heating requirement

2280.37 (98)

Space heat from heat pump

(98) x (304a) x (305) x (306) = 2291.77 (307a)

Space heat from boilers

(98) x (304b) x (305) x (306) = 1128.78 (307b)

Water heating

Annual water heating requirement

1664.70 (64)

Water heat from heat pump	$(64) \times (303a) \times (305a) \times (306) =$	1673.03	(310a)
Water heat from boilers	$(64) \times (303b) \times (305a) \times (306) =$	824.03	(310b)
Electricity used for heat distribution	$0.01 \times [(307a)...(307e) + (310a)...(310e)] =$	59.18	(313)
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside		132.46	(330a)
Total electricity for the above, kWh/year		132.46	(331)
Electricity for lighting (Appendix L)		285.24	(332)
Total delivered energy for all uses	$(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =$	6335.31	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	2291.77	x	4.24	x 0.01 =	97.17	(340a)
Space heating from boilers	1128.78	x	4.24	x 0.01 =	47.86	(340b)
Water heating from heat pump	1673.03	x	4.24	x 0.01 =	70.94	(342a)
Water heating from boilers	824.03	x	4.24	x 0.01 =	34.94	(342b)
Pumps and fans	132.46	x	13.19	x 0.01 =	17.47	(349)
Electricity for lighting	285.24	x	13.19	x 0.01 =	37.62	(350)
Additional standing charges					120.00	(351)
Total energy cost				$(340a)...(342e) + (345)...(354) =$	426.00	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.65	(357)
SAP value	76.93	
SAP rating (section 13)	77	(358)
SAP band	C	

12b. CO₂ emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of heat pump	280.00					(367a)
CO ₂ emissions from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1416.00	x	0.519	=	734.90	(367)
Efficiency of boilers	89.50					(367b)
CO ₂ emissions from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	2181.91	x	0.216	=	471.29	(368)
Electrical energy for community heat distribution	59.18	x	0.519	=	30.71	(372)
Total CO ₂ associated with community systems					1236.91	(373)
Total CO ₂ associated with space and water heating					1236.91	(376)
Pumps and fans	132.46	x	0.519	=	68.75	(378)
Electricity for lighting	285.24	x	0.519	=	148.04	(379)
Total CO ₂ , kg/year				$(376)...(382) =$	1453.70	(383)
Dwelling CO ₂ emission rate				$(383) \div (4) =$	23.01	(384)
EI value					81.99	
EI rating (section 14)					82	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)
Primary energy from other sources (space heating)					
Efficiency of heat pump	280.00				(367a)
Primary energy from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1416.00	x	3.07	=	4347.12 (367)
Efficiency of boilers	89.50				(367b)
Primary energy from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	2181.91	x	1.22	=	2661.93 (368)
Electrical energy for community heat distribution	59.18	x	3.07	=	181.67 (372)
Total primary energy associated with community systems					7190.72 (373)
Total primary energy associated with space and water heating					7190.72 (376)
Pumps and fans	132.46	x	3.07	=	406.65 (378)
Electricity for lighting	285.24	x	3.07	=	875.69 (379)
Primary energy kWh/year					8473.07 (383)
Dwelling primary energy rate kWh/m2/year					134.13 (384)

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 Jonathan Peck	Assessor number	10160
Client		Last modified	28/10/2020
Address	2B TF Block B x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	63.47 (1a)	x	2.75 (2a)	=	174.54 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 63.47 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 174.54 (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	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)
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If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.20 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.17 (21)
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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)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m

0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.20 (22b)
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system	0.50 (23a)
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If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	77.35 (23c)
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a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]

0.33	0.33	0.32	0.30	0.30	0.27	0.27	0.27	0.28	0.30	0.30	0.31 (24a)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.33	0.33	0.32	0.30	0.30	0.27	0.27	0.27	0.28	0.30	0.30	0.31 (25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	x 1.00	= 1.98		(26)						
Window			12.00	x 1.33	= 15.91		(27)						
External wall			64.32	x 0.17	= 10.93		(29a)						
Party wall			19.50	x 0.00	= 0.00		(32)						
Roof			63.47	x 0.11	= 6.98		(30)						
Total area of external elements ΣA, m ²			141.77				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	35.81	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						100.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						13.20	(36)						
Total fabric heat loss					(33) + (36) =	49.00	(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)	19.01	18.76	18.52	17.29	17.05	15.83	15.83	15.58	16.31	17.05	17.54	18.03	(38)
Heat transfer coefficient, W/K (37)m + (38)m	68.01	67.76	67.52	66.29	66.05	64.83	64.83	64.58	65.32	66.05	66.54	67.03	
	Average = Σ(39)1...12/12 =											66.23	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.07	1.07	1.06	1.04	1.04	1.02	1.02	1.02	1.03	1.04	1.05	1.06	
	Average = Σ(40)1...12/12 =											1.04	(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												2.08	(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$												83.55	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month $V_{d,m} = \text{factor from Table 1c} \times (43)$														
	91.90	88.56	85.22	81.88	78.54	75.19	75.19	78.54	81.88	85.22	88.56	91.90		
												$\Sigma(44)1...12 =$	1002.59	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)														
	136.29	119.20	123.00	107.24	102.90	88.79	82.28	94.42	95.54	111.35	121.55	131.99		
												$\Sigma(45)1...12 =$	1314.55	(45)
Distribution loss $0.15 \times (45)m$														
	20.44	17.88	18.45	16.09	15.43	13.32	12.34	14.16	14.33	16.70	18.23	19.80	(46)	
Storage volume (litres) including any solar or WWHRS storage within same vessel												3.00	(47)	
Water storage loss:														
b) Manufacturer's declared loss factor is not known														
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.02	(51)	
Volume factor from Table 2a												3.42	(52)	
Temperature factor from Table 2b												1.00	(53)	
Energy lost from water storage (kWh/day) $(47) \times (51) \times (52) \times (53)$												0.22	(54)	
Enter (50) or (54) in (55)												0.22	(55)	
Water storage loss calculated for each month $(55) \times (41)m$														
	6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(56)	

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

6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(57)
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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)
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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)
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Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m

166.29	146.30	153.00	136.27	132.90	117.82	112.28	124.41	124.57	141.35	150.58	161.99	(62)
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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)
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Output from water heater for each month (kWh/month) (62)m + (63)m

166.29	146.30	153.00	136.27	132.90	117.82	112.28	124.41	124.57	141.35	150.58	161.99	
Σ(64)1...12 =											1667.75	(64)

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

69.31	61.31	64.90	58.88	58.21	52.75	51.36	55.39	54.99	61.02	63.64	67.88	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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Metabolic gains (Table 5)

103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89	103.89	(66)
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

16.21	14.40	11.71	8.86	6.63	5.59	6.04	7.86	10.54	13.39	15.63	16.66	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

181.61	183.49	178.74	168.63	155.87	143.88	135.86	133.98	138.73	148.84	161.60	173.59	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39	33.39	(69)
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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)

-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	-83.11	(71)
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Water heating gains (Table 5)

93.17	91.24	87.23	81.78	78.24	73.26	69.03	74.45	76.38	82.02	88.39	91.24	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

345.15	343.29	331.84	313.44	294.90	276.90	265.10	270.45	279.82	298.41	319.78	335.66	(73)
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6. Solar gains

	Access factor Table 6d	Area m²	Solar flux W/m²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
SouthWest	0.77	x 12.00	x 36.79	x 0.9 x 0.45	x 0.80	= 110.15	(79)

Solar gains in watts Σ(74)m...(82)m

110.15	187.63	256.72	318.09	356.29	353.71	341.02	312.52	277.98	207.37	131.94	94.27	(83)
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Total gains - internal and solar (73)m + (83)m

455.30	530.92	588.57	631.53	651.19	630.61	606.12	582.97	557.79	505.78	451.72	429.93	(84)
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7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)	21.00	(85)
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
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Utilisation factor for gains for living area n1,m (see Table 9a)

0.95	0.92	0.88	0.82	0.71	0.57	0.44	0.47	0.65	0.84	0.92	0.96	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

18.96	19.26	19.67	20.16	20.56	20.84	20.94	20.93	20.75	20.23	19.52	18.92	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.02	20.03	20.03	20.05	20.05	20.07	20.07	20.07	20.06	20.05	20.04	20.04	(88)
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Utilisation factor for gains for rest of dwelling n2,m

0.94	0.91	0.87	0.79	0.67	0.51	0.36	0.39	0.59	0.81	0.91	0.95	(89)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

17.31	17.73	18.32	19.02	19.56	19.92	20.03	20.02	19.81	19.12	18.12	17.25	(90)
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Living area fraction

Living area ÷ (4) = 0.42 (91)

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

18.01	18.38	18.89	19.50	19.98	20.30	20.41	20.40	20.21	19.59	18.71	17.95	(92)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

18.01	18.38	18.89	19.50	19.98	20.30	20.41	20.40	20.21	19.59	18.71	17.95	(93)
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8. Space heating requirement

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Utilisation factor for gains, ηm

0.92	0.89	0.85	0.77	0.67	0.52	0.39	0.42	0.60	0.79	0.89	0.93	(94)
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Useful gains, ηmGm, W (94)m x (84)m

419.87	472.81	497.55	488.08	435.33	330.61	235.04	243.30	337.12	400.18	402.73	400.14	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

932.08	913.15	836.35	702.68	547.04	369.81	247.17	258.50	398.77	593.69	772.63	921.86	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

381.09	295.91	252.07	154.51	83.12	0.00	0.00	0.00	0.00	143.97	266.33	388.16	
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Σ(98)1...5, 10...12 = 1965.15 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) = 30.96 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)

'0' if none 0.00 (301)

Fraction of space heat from community system

1 - (301) = 1.00 (302)

Fraction of community heat from heat pump

0.67 (303a)

Fraction of community heat from boilers

0.33 (303b)

Fraction of total space heat from community heat pump

(302) x (303a) = 0.67 (304a)

Fraction of total space heat from community boilers

(302) x (303b) = 0.33 (304b)

Factor for control and charging method (Table 4c(3)) for community space heating

1.00 (305)

Factor for charging method (Table 4c(3)) for community water heating

1.00 (305a)

Distribution loss factor (Table 12c) for community heating system

1.50 (306)

Space heating

Annual space heating requirement

1965.15 (98)

Space heat from heat pump

(98) x (304a) x (305) x (306) = 1974.97 (307a)

Space heat from boilers

(98) x (304b) x (305) x (306) = 972.75 (307b)

Water heating

Annual water heating requirement

1667.75 (64)

Water heat from heat pump	$(64) \times (303a) \times (305a) \times (306) =$	1676.09	(310a)
Water heat from boilers	$(64) \times (303b) \times (305a) \times (306) =$	825.54	(310b)
Electricity used for heat distribution	$0.01 \times [(307a)...(307e) + (310a)...(310e)] =$	54.49	(313)
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside		133.09	(330a)
Total electricity for the above, kWh/year		133.09	(331)
Electricity for lighting (Appendix L)		286.23	(332)
Total delivered energy for all uses	$(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =$	5868.67	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	1974.97	x	4.24	x 0.01 =	83.74	(340a)
Space heating from boilers	972.75	x	4.24	x 0.01 =	41.24	(340b)
Water heating from heat pump	1676.09	x	4.24	x 0.01 =	71.07	(342a)
Water heating from boilers	825.54	x	4.24	x 0.01 =	35.00	(342b)
Pumps and fans	133.09	x	13.19	x 0.01 =	17.55	(349)
Electricity for lighting	286.23	x	13.19	x 0.01 =	37.75	(350)
Additional standing charges					120.00	(351)
Total energy cost				$(340a)...(342e) + (345)...(354) =$	406.36	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.57	(357)
SAP value	78.05	
SAP rating (section 13)	78	(358)
SAP band	C	

12b. CO₂ emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of heat pump	280.00					(367a)
CO ₂ emissions from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1303.95	x	0.519	=	676.75	(367)
Efficiency of boilers	89.50					(367b)
CO ₂ emissions from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	2009.26	x	0.216	=	434.00	(368)
Electrical energy for community heat distribution	54.49	x	0.519	=	28.28	(372)
Total CO ₂ associated with community systems					1139.03	(373)
Total CO ₂ associated with space and water heating					1139.03	(376)
Pumps and fans	133.09	x	0.519	=	69.07	(378)
Electricity for lighting	286.23	x	0.519	=	148.55	(379)
Total CO ₂ , kg/year				$(376)...(382) =$	1356.66	(383)
Dwelling CO ₂ emission rate				$(383) \div (4) =$	21.37	(384)
EI value					83.24	
EI rating (section 14)					83	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year		Primary factor		Primary energy (kWh/year)
Primary energy from other sources (space heating)					
Efficiency of heat pump	280.00				(367a)
Primary energy from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1303.95	x	3.07	=	4003.13 (367)
Efficiency of boilers	89.50				(367b)
Primary energy from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	2009.26	x	1.22	=	2451.29 (368)
Electrical energy for community heat distribution	54.49	x	3.07	=	167.30 (372)
Total primary energy associated with community systems					6621.72 (373)
Total primary energy associated with space and water heating					6621.72 (376)
Pumps and fans	133.09	x	3.07	=	408.58 (378)
Electricity for lighting	286.23	x	3.07	=	878.72 (379)
Primary energy kWh/year					7909.02 (383)
Dwelling primary energy rate kWh/m2/year					124.61 (384)

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 Jonathan Peck	Assessor number	10160
Client		Last modified	09/12/2020
Address	2B MF Block B x, Reading , RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)
Lowest occupied	70.72 (1a)	x	2.75 (2a)	=	194.48 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 70.72 (4)				
Dwelling volume	(3a) + (3b) + (3c) + (3d)...(3n) = 194.48 (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	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)
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If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.20 (18)
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Number of sides on which the dwelling is sheltered	3 (19)
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Shelter factor	1 - [0.075 x (19)] = 0.78 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.16 (21)
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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)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m

0.20	0.19	0.19	0.17	0.17	0.15	0.15	0.14	0.16	0.17	0.17	0.18 (22b)
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Calculate effective air change rate for the applicable case:

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

0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50 (24c)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50 (25)
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	κ-value, kJ/m ² .K	A x κ, kJ/K						
Door			1.98	x 1.00	= 1.98		(26)						
Window			9.12	x 1.33	= 12.09		(27)						
External wall			49.80	x 0.17	= 8.47		(29a)						
Party wall			41.40	x 0.00	= 0.00		(32)						
Total area of external elements ΣA, m ²			60.90				(31)						
Fabric heat loss, W/K = Σ(A × U)						(26)...(30) + (32) =	22.54 (33)						
Heat capacity Cm = Σ(A × κ)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)						
Thermal mass parameter (TMP) in kJ/m ² K							100.00 (35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K							8.55 (36)						
Total fabric heat loss						(33) + (36) =	31.09 (37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 × (25)m × (5)	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	32.09	(38)
Heat transfer coefficient, W/K (37)m + (38)m	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	63.18	
	Average = Σ(39)1...12/12 =										63.18	(39)	
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	
	Average = Σ(40)1...12/12 =										0.89	(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												2.26	(42)	
Annual average hot water usage in litres per day $V_{d,average} = (25 \times N) + 36$												87.96	(43)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month $V_{d,m}$ = factor from Table 1c x (43)														
	96.75	93.24	89.72	86.20	82.68	79.16	79.16	82.68	86.20	89.72	93.24	96.75		
												$\sum(44)1...12 =$	1055.49	(44)
Energy content of hot water used = $4.18 \times V_{d,m} \times n_m \times T_m / 3600$ kWh/month (see Tables 1b, 1c 1d)														
	143.48	125.49	129.50	112.90	108.33	93.48	86.62	99.40	100.59	117.22	127.96	138.96		
												$\sum(45)1...12 =$	1383.92	(45)
Distribution loss $0.15 \times (45)m$														
	21.52	18.82	19.42	16.93	16.25	14.02	12.99	14.91	15.09	17.58	19.19	20.84	(46)	
Storage volume (litres) including any solar or WWHRS storage within same vessel												3.00	(47)	
Water storage loss:														
b) Manufacturer's declared loss factor is not known														
Hot water storage loss factor from Table 2 (kWh/litre/day)												0.02	(51)	
Volume factor from Table 2a												3.42	(52)	
Temperature factor from Table 2b												1.00	(53)	
Energy lost from water storage (kWh/day) $(47) \times (51) \times (52) \times (53)$												0.22	(54)	
Enter (50) or (54) in (55)												0.22	(55)	
Water storage loss calculated for each month $(55) \times (41)m$														
	6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)														

6.74	6.08	6.74	6.52	6.74	6.52	6.74	6.74	6.52	6.74	6.52	6.74	(57)
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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)
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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)
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Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$

173.48	152.59	159.49	141.93	138.33	122.51	116.62	129.40	129.62	147.22	156.99	168.95	(62)
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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)
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Output from water heater for each month (kWh/month) (62)m + (63)m

173.48	152.59	159.49	141.93	138.33	122.51	116.62	129.40	129.62	147.22	156.99	168.95	
$\Sigma(64)1...12 =$											1737.11	(64)

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

71.71	63.40	67.06	60.76	60.02	54.31	52.80	57.05	56.67	62.98	65.77	70.20	(65)
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Metabolic gains (Table 5)

113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	(66)
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

18.82	16.72	13.59	10.29	7.69	6.50	7.02	9.12	12.24	15.55	18.15	19.34	(67)
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

198.97	201.04	195.83	184.76	170.77	157.63	148.85	146.79	151.99	163.07	177.05	190.19	(68)
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	34.32	(69)
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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)
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Losses e.g. evaporation (Table 5)

-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	(71)
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Water heating gains (Table 5)

96.38	94.35	90.13	84.39	80.67	75.42	70.97	76.68	78.71	84.64	91.35	94.36	(72)
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

371.12	369.05	356.51	336.39	316.09	296.51	283.79	289.54	299.90	320.21	343.50	360.84	(73)
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6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W	
NorthWest	0.77	x 9.12	x 11.28	x 0.9 x 0.45	x 0.80	= 25.67	(81)

Solar gains in watts $\Sigma(74)m...(82)m$

25.67	52.26	94.15	154.62	207.84	221.57	207.28	165.24	114.72	63.86	32.30	20.96	(83)
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Total gains - internal and solar (73)m + (83)m

396.80	421.31	450.66	491.01	523.92	518.08	491.07	454.79	414.62	384.07	375.80	381.81	(84)
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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
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Utilisation factor for gains for living area n1,m (see Table 9a)

0.97	0.96	0.94	0.89	0.80	0.65	0.52	0.57	0.77	0.91	0.96	0.97	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.14	19.30	19.63	20.09	20.53	20.82	20.94	20.91	20.68	20.15	19.56	19.09	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	20.17	(88)
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Utilisation factor for gains for rest of dwelling n2,m

0.96	0.95	0.93	0.87	0.76	0.60	0.44	0.49	0.72	0.89	0.95	0.97	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

17.65	17.89	18.37	19.02	19.62	20.00	20.13	20.10	19.83	19.11	18.27	17.58	(90)
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Living area fraction

Living area ÷ (4) = 0.48 (91)

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

18.37	18.57	18.98	19.54	20.06	20.39	20.52	20.49	20.24	19.61	18.89	18.30	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

18.37	18.57	18.98	19.54	20.06	20.39	20.52	20.49	20.24	19.61	18.89	18.30	(93)
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8. Space heating requirement

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec

Utilisation factor for gains, ηm

0.95	0.94	0.91	0.86	0.76	0.61	0.47	0.52	0.73	0.88	0.94	0.96	(94)
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Useful gains, ηmGm, W (94)m x (84)m

377.66	396.18	412.08	421.14	396.84	317.24	231.51	236.78	302.25	337.38	351.57	365.14	(95)
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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)
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

888.98	863.59	788.35	672.10	528.07	366.02	247.42	258.68	388.07	569.24	745.00	891.08	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

380.42	314.10	279.95	180.69	97.63	0.00	0.00	0.00	0.00	172.50	283.27	391.30	
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Σ(98)1...5, 10...12 = 2099.87 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) = 29.69 (99)

9b. Energy requirements - community heating scheme

Fraction of space heat from secondary/supplementary system (table 11)

'0' if none 0.00 (301)

Fraction of space heat from community system

1 - (301) = 1.00 (302)

Fraction of community heat from heat pump

0.67 (303a)

Fraction of community heat from boilers

0.33 (303b)

Fraction of total space heat from community heat pump

(302) x (303a) = 0.67 (304a)

Fraction of total space heat from community boilers

(302) x (303b) = 0.33 (304b)

Factor for control and charging method (Table 4c(3)) for community space heating

1.00 (305)

Factor for charging method (Table 4c(3)) for community water heating

1.00 (305a)

Distribution loss factor (Table 12c) for community heating system

1.50 (306)

Space heating

Annual space heating requirement

2099.87 (98)

Space heat from heat pump

(98) x (304a) x (305) x (306) = 2110.37 (307a)

Space heat from boilers

(98) x (304b) x (305) x (306) = 1039.44 (307b)

Water heating

Annual water heating requirement

1737.11 (64)

Water heat from heat pump

(64) x (303a) x (305a) x (306) = 1745.80 (310a)

Water heat from boilers	$(64) \times (303b) \times (305a) \times (306) =$	859.87	(310b)
Electricity used for heat distribution	$0.01 \times [(307a)...(307e) + (310a)...(310e)] =$	57.55	(313)
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside		49.35	(330a)
Total electricity for the above, kWh/year		49.35	(331)
Electricity for lighting (Appendix L)		332.38	(332)
Total delivered energy for all uses	$(307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) =$	6137.22	(338)

10b. Fuel costs - community heating scheme

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating from heat pump	2110.37	x	4.24	x 0.01 =	89.48	(340a)
Space heating from boilers	1039.44	x	4.24	x 0.01 =	44.07	(340b)
Water heating from heat pump	1745.80	x	4.24	x 0.01 =	74.02	(342a)
Water heating from boilers	859.87	x	4.24	x 0.01 =	36.46	(342b)
Pumps and fans	49.35	x	13.19	x 0.01 =	6.51	(349)
Electricity for lighting	332.38	x	13.19	x 0.01 =	43.84	(350)
Additional standing charges					120.00	(351)
Total energy cost			$(340a)...(342e) + (345)...(354) =$		414.38	(355)

11b. SAP rating - community heating scheme

Energy cost deflator (Table 12)	0.42	(356)
Energy cost factor (ECF)	1.50	(357)
SAP value	79.02	
SAP rating (section 13)	79	(358)
SAP band	C	

12b. CO₂ emissions - community heating scheme

	Energy kWh/year		Emission factor		Emissions (kg/year)	
Emissions from other sources (space heating)						
Efficiency of heat pump	280.00					(367a)
CO ₂ emissions from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1377.20	x	0.519	=	714.77	(367)
Efficiency of boilers	89.50					(367b)
CO ₂ emissions from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	2122.13	x	0.216	=	458.38	(368)
Electrical energy for community heat distribution	57.55	x	0.519	=	29.87	(372)
Total CO ₂ associated with community systems					1203.02	(373)
Total CO ₂ associated with space and water heating					1203.02	(376)
Pumps and fans	49.35	x	0.519	=	25.61	(378)
Electricity for lighting	332.38	x	0.519	=	172.51	(379)
Total CO ₂ , kg/year				$(376)..(382) =$	1401.14	(383)
Dwelling CO ₂ emission rate				$(383) \div (4) =$	19.81	(384)
EI value					83.78	
EI rating (section 14)					84	(385)
EI band					B	

13b. Primary energy - community heating scheme

	Energy kWh/year	Primary factor	Primary energy (kWh/year)
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Primary energy from other sources (space heating)

Efficiency of heat pump	280.00					(367a)
Primary energy from heat pump $[(307a)+(310a)] \times 100 \div (367a) =$	1377.20	x	3.07	=	4228.02	(367)
Efficiency of boilers	89.50					(367b)
Primary energy from boilers $[(307b)+(310b)] \times 100 \div (367b) =$	2122.13	x	1.22	=	2589.00	(368)
Electrical energy for community heat distribution	57.55	x	3.07	=	176.69	(372)
Total primary energy associated with community systems					6993.71	(373)
Total primary energy associated with space and water heating					6993.71	(376)
Pumps and fans	49.35	x	3.07	=	151.51	(378)
Electricity for lighting	332.38	x	3.07	=	1020.42	(379)
Primary energy kWh/year					8165.64	(383)
Dwelling primary energy rate kWh/m ² /year					115.46	(384)

Appendix D

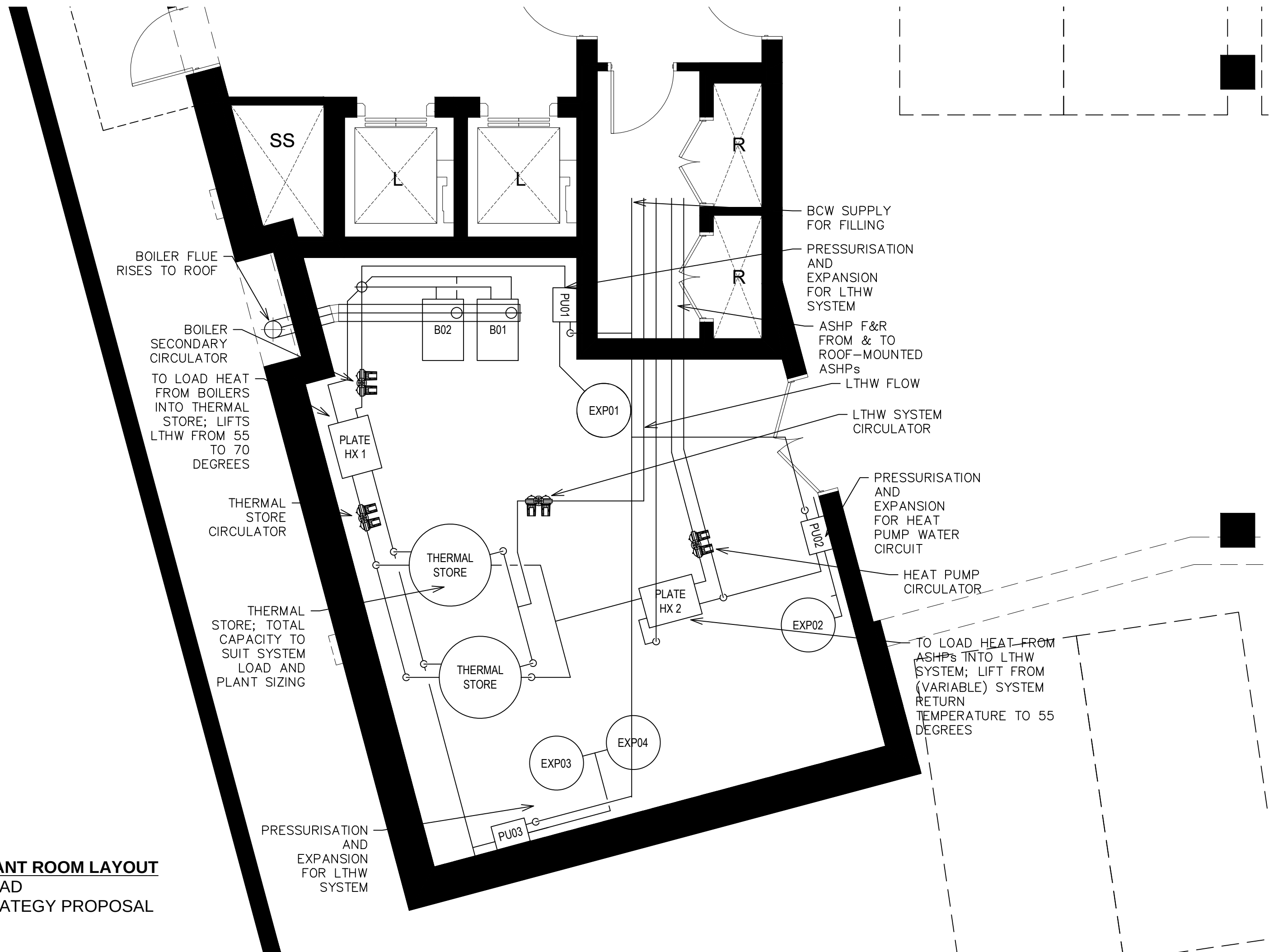
Estimate annual heating costs

Indicative Energy Centre Layout

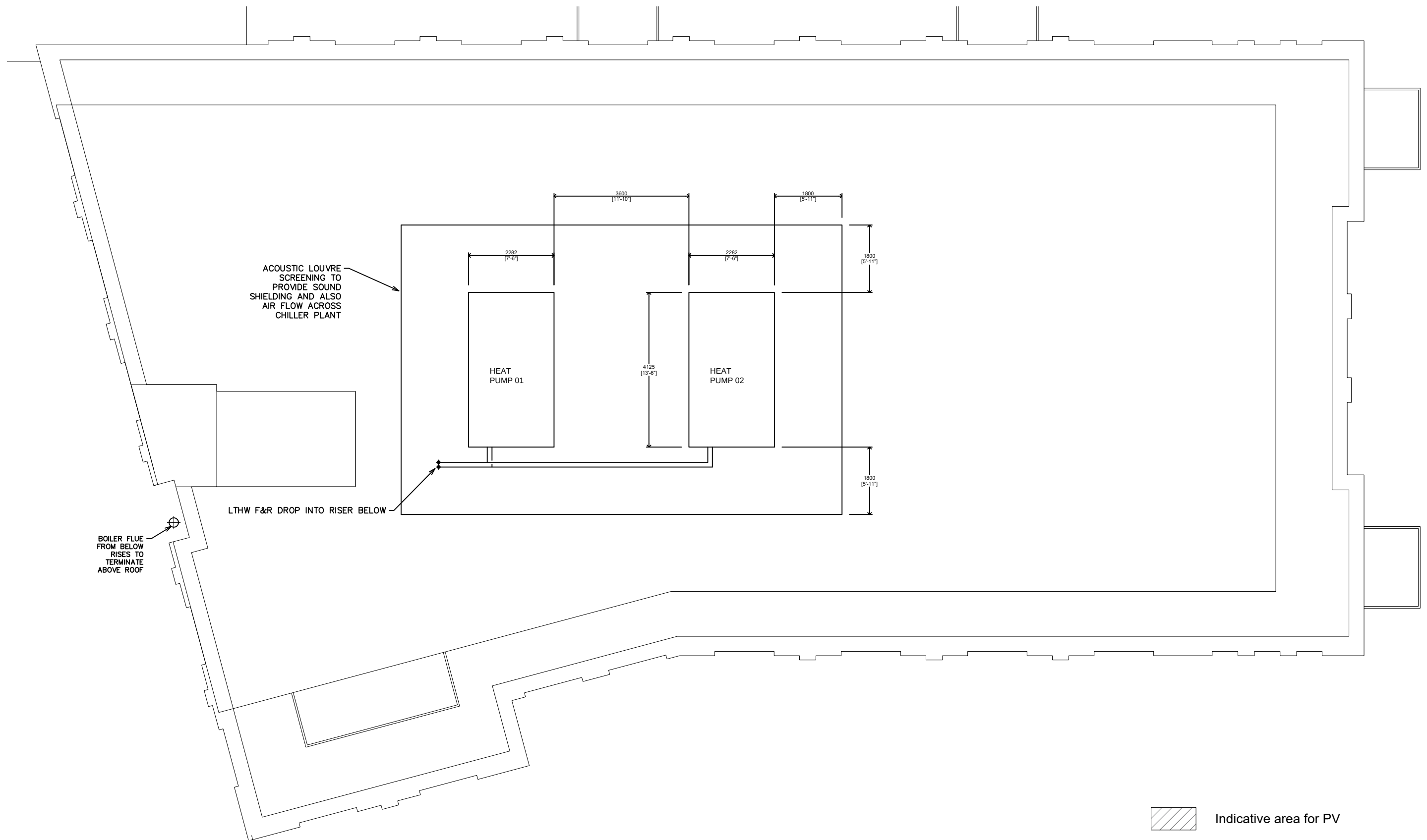
Indicative Roof Plant Layout

Estimated annual heating costs (£/yr)

System Description	Variable cost	Fixed costs				Total
		Maintenance	Utilities	Billing	Plant replacement	
Open Loop Ground Source Heat Pump	£196.00	£335.00	£60.00	£85.00	£412.00	£1,088.00
Water Source Heat Pump	£216.00	£326.00	£60.00	£85.00	£371.00	£1,058.00
Air Source Heat Pump	£240.00	£215.00	£60.00	£85.00	£340.00	£940.00
Air Source Heat Pump and Boilers	£212.00	£215.00	£95.00	£85.00	£290.00	£897.00



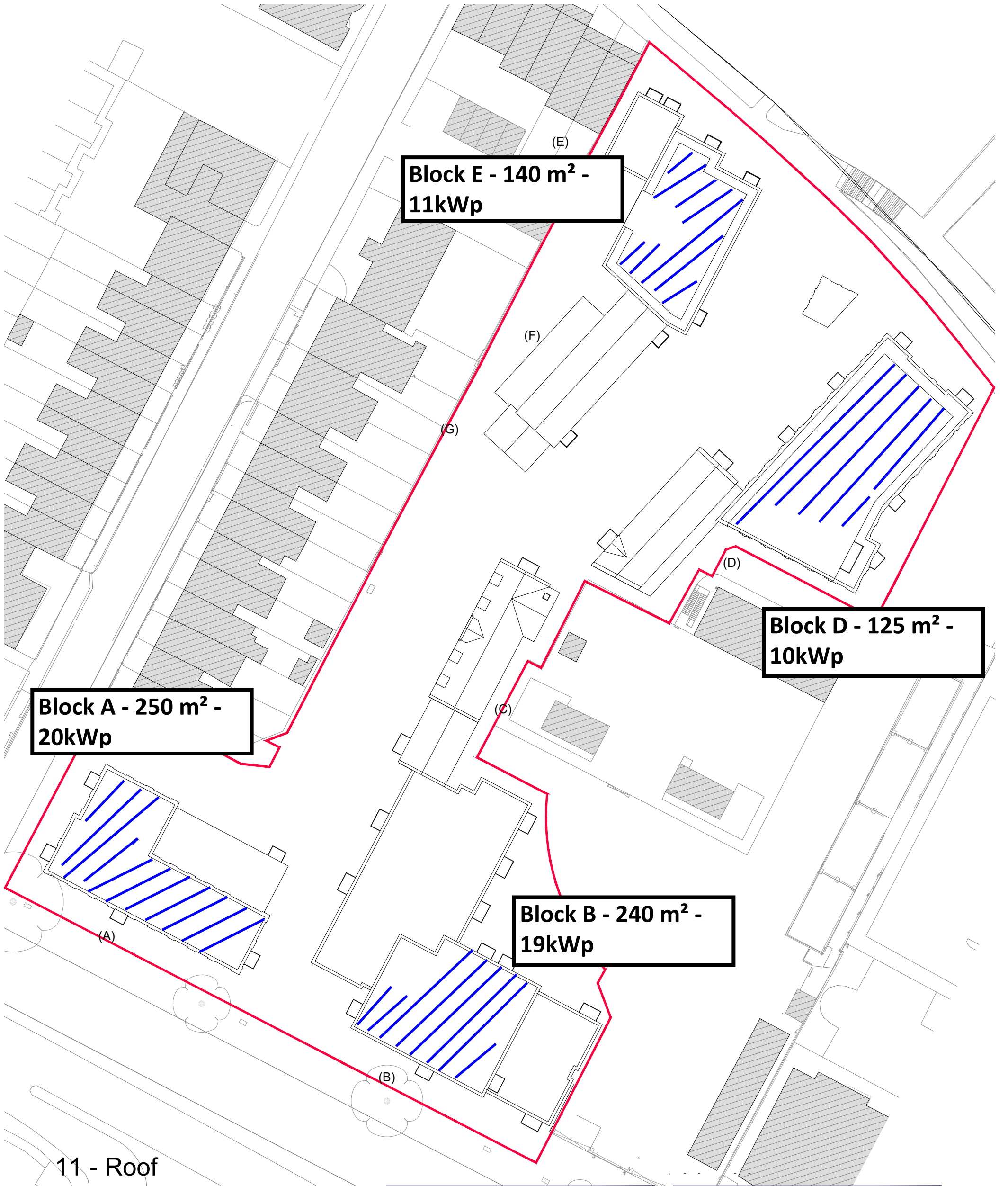
BLOCK D PLANT ROOM LAYOUT
 VASTERN ROAD
 ENERGY STRATEGY PROPOSAL
 SCALE 1:50
 23.10.2020



BLOCK D ROOF LAYOUT
 VASTERN ROAD
 ENERGY STRATEGY PROPOSAL
 SCALE 1:100
 23.10.2020

Appendix E

PV Panels – Indicative Roof Plan



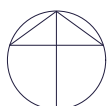
**Block A - 250 m² -
20kWp**

**Block E - 140 m² -
11kWp**

**Block D - 125 m² -
10kWp**

**Block B - 240 m² -
19kWp**

11 - Roof



project
Vastern Road
Reading

drawing
Proposed Floor Plans
11 - Roof

date
January 2020

scale @ a3
1:500

drawn
EE

drawing number
448.SK.111

revision
/

revision
date
prepared
description

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