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Energy Statement

Berkeley Homes (Oxford & Chiltern) Ltd.

Vastern Road, Reading

Final V3

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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 to all blocks with the exception of one, providing heat recovery & cooling whilst contributing further to the overall CO₂ reduction of the development;
- > Efficient & simple systems for residents to use;
- > High levels of control for resident comfort;
- > Greater tariff flexibility for residents to reduce their heating costs;
- > Application of PV panels to all suitable roof areas, providing generating potential for the overall development.

The development proposes to supply heat from low carbon electricity. This delivers significant CO₂ savings to the development when assessed 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 **54.2%** reduction in Regulated CO₂ emissions. This goes significantly 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 £170,100.

Regulated Carbon dioxide emissions (kg CO ₂ per annum)	
	SAP 10.1 Emission Factors
Baseline	206,400
After <i>Energy Efficiency Measures</i>	101,700
After <i>Renewable Measures</i>	94,500
Total % Savings (On-site)	54.2%

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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.

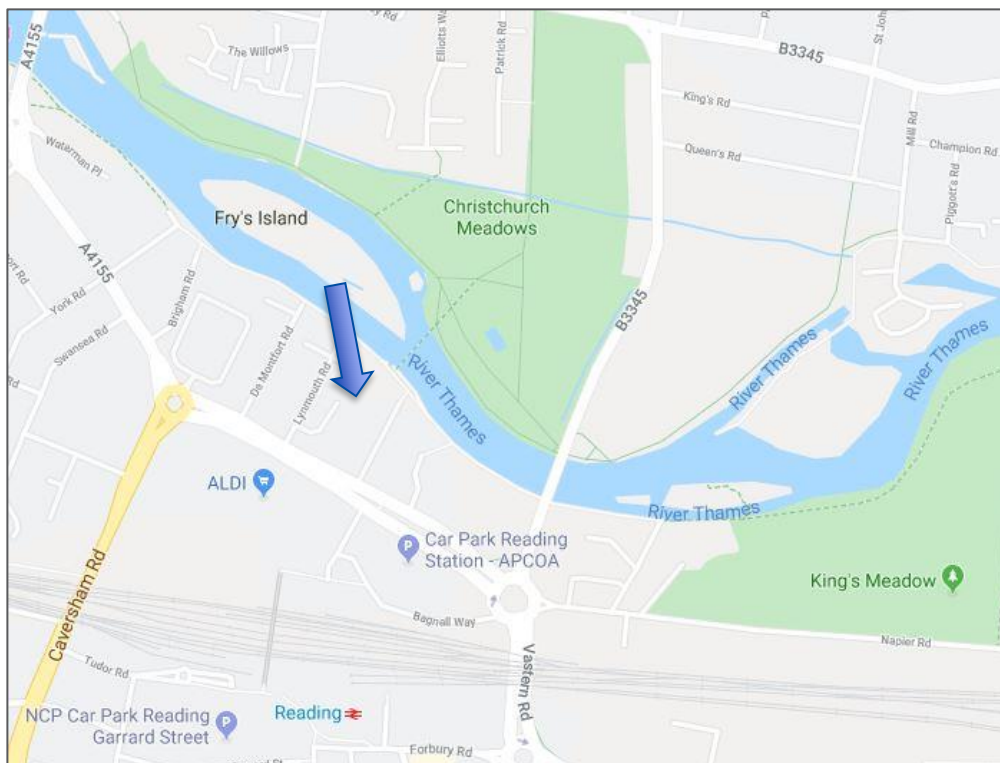


Figure 1: Site Location (Source: Imagery @ 2019 Google, Map data ©2019 Google)

Development Proposals

- 2.2 Consent is sought for the development of the site to deliver 208 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 very recently, 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 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 a CHP plant, or other form 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.'*
- 2.9 This report will demonstrate how following a gas CHP strategy will lead to an increase in development CO₂ emissions. Alternatively, a 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 through on-site endeavours.

Berkeley Homes Commitments

- 2.10** 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.
- 2.11** 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.

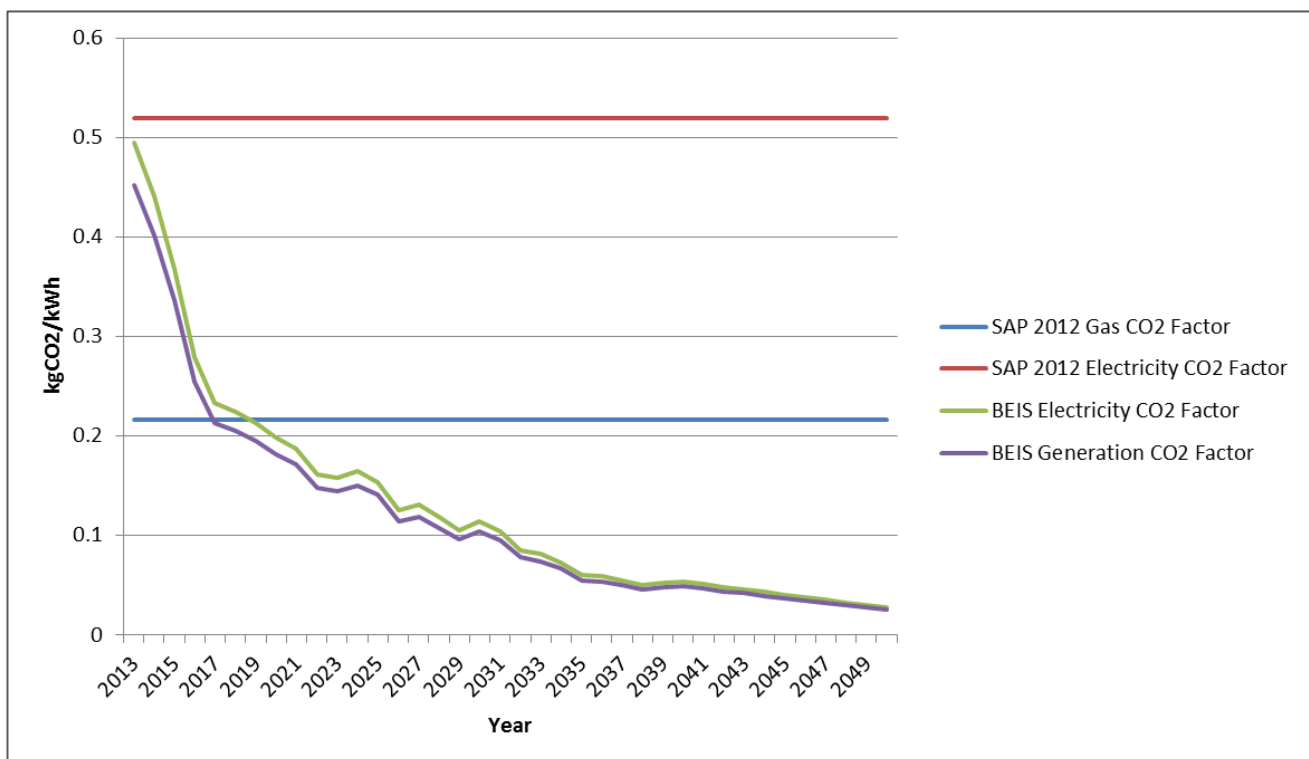


Figure 2: SAP 2012 and BEIS Projected Emission Factors (2013 – 2050)

- 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 recently been released for consultation. As part of this SAP 10.1 revised emission factors have been published. It is not expected that a new version of Part L will be formally adopted until autumn 2020 at the earliest. By this point the SAP 2012 emission factors will be 8 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. It therefore gives foresight regarding the trajectory of CO₂ emission factors.
- 3.7** The proposed changes to these are summarised in Table 1.

	SAP 2012	SAP 10.1	Change
Gas Emission factor (kg CO ₂ /kWh)	0.216	0.210	3% reduction
Electricity Emission factor (kg CO ₂ /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 3: Regulated Baseline Case – SAP 10.1 Emission Factors	
	Regulated CO ₂ (kg/year)
Development Baseline	206,400

Table 2: SAP 10.1 Baseline Emissions

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) to all blocks, with the exception of Block A.
- 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 Block A. 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, which occur when highly conductive elements (e.g. metal studs) in the wall construction enable a low resistance escape route for heat. As energy efficiency standards improve, an increased importance is being placed on addressing heat losses through thermal bridging.

4.9 Figure 3 illustrates the benefits of reducing thermal bridges.

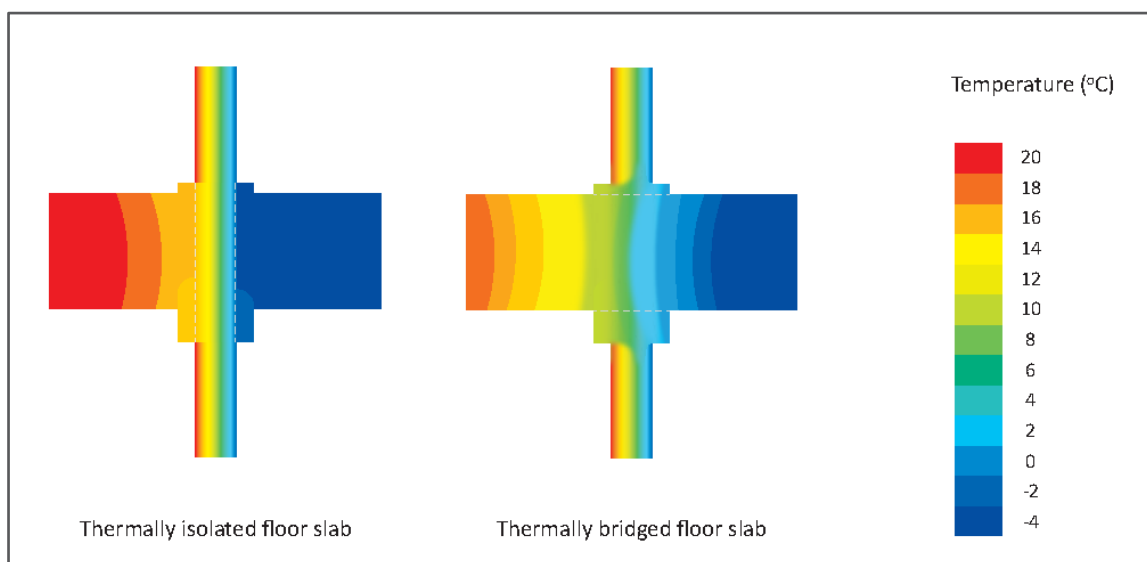


Figure 3: Thermal Bridging

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 (0.30W/m.K), Sills (0.04W/m.K), and Jambs (0.05W/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 It is proposed that all dwellings are heated from electric resistance heaters, with hot water provided from insulated cylinders in each dwelling. The Applicant has sought to utilise electricity to heat the dwellings as a result of the continuing decarbonisation of the electricity grid. This is further explored in Section 5 of this report.

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 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 The measures outlined in Section 4 enable the development to exceed the Target Fabric Energy Efficiency (TFEE) requirements of Building Regulations Part L1A (2013), as shown in Table 3 below.

Residential - Example Unit Type	Unit Area (m ²)	No. Units	TFEE (kWh/m ² /yr)	DFEE (kWh/m ² /yr)
1 Bed Mid-Floor (SE facing)	50	47	34.3	34.1
2 Bed Mid-Floor (NW facing)	71	68	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)			13.3%	

Table 3: TFEE/DFEE results for sample dwelling types

CO₂ Emissions After Demand Reduction Measures

4.23 Table 4, below, show the CO₂ savings following the aforementioned demand reduction measures.

Demand Reduction (kg CO ₂ per annum)	
	Regulated Emissions
Baseline	206,400
After <i>Energy Efficiency Measures</i>	101,700
Total % Savings (On-site)	50.7%

Table 4: Residential Demand Reduction CO₂

5. HEATING STRATEGY

- 5.1 As outlined in Section 3 of this report, the use of SAP 10.1 emissions factors is much more reflective of the projected trend for the CO₂ intensity of the electricity grid. As such, it is more appropriate to assess the proposed energy strategy for Vastern Road in line with SAP 10. Emission factors.
- 5.2 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 follows:
- > Decentralised heating network with a heat source which is not gas-fired;
 - > Direct electric systems to each flat.
- 5.3 Using gas-fired combustion plant as a heat source for a heat network, particularly CHP, will increase development CO₂ emissions against the CO₂ baseline.

Utility Availability – Heat & Electricity

- 5.4 The connection of the development to an area-wide heat network in central Reading would provide a resilient supply of low carbon heat. However, it is understood that there are no such existing or imminently planned networks. 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 risk that the Vastern Road development will remain on a site only heating strategy for a very long period too high.
- 5.5 The size of the Vastern Road development means that residents would not benefit from the economy of scale which those on larger heat networks tend to. Residents at Vastern Road would therefore likely be subject to heating charges in excess of what they would be experiencing if they

were not connected to a heat network. As such, it cannot be recommended that a site heat network for Vastern Road be proposed.

- 5.6** Additionally, without connection to an area wide low carbon heat network, the site would need to include an on-site Energy Centre for the generation of heat. No on-site generation source would provide CO₂ reductions equivalent to those offered by an area heat network fed from waste heat sources. For instance heat pump systems, although lower in CO₂ than gas CHP, would still encounter difficulties with ensuring distribution losses were not high.
- 5.7** Whilst a supply of low carbon heat is not available to the site, low carbon electricity is. This enables CO₂ reductions to be locked into the energy strategy from day 1, with no risk that any site heat network may never connect to a wider area one and therefore lock in higher CO₂ emissions for the duration of the development.

Proposed Strategy - Direct Electric Heating

- 5.8** Policy CC4 of the RBC Local Plan seeks for CHP-led decentralised heating to be an ambition of new developments. Figure 4, below, shows how the adoption of such a strategy would lead to significantly increased CO₂ emissions throughout the lifetime of the development when compared with a direct electric strategy for the generation of heat.

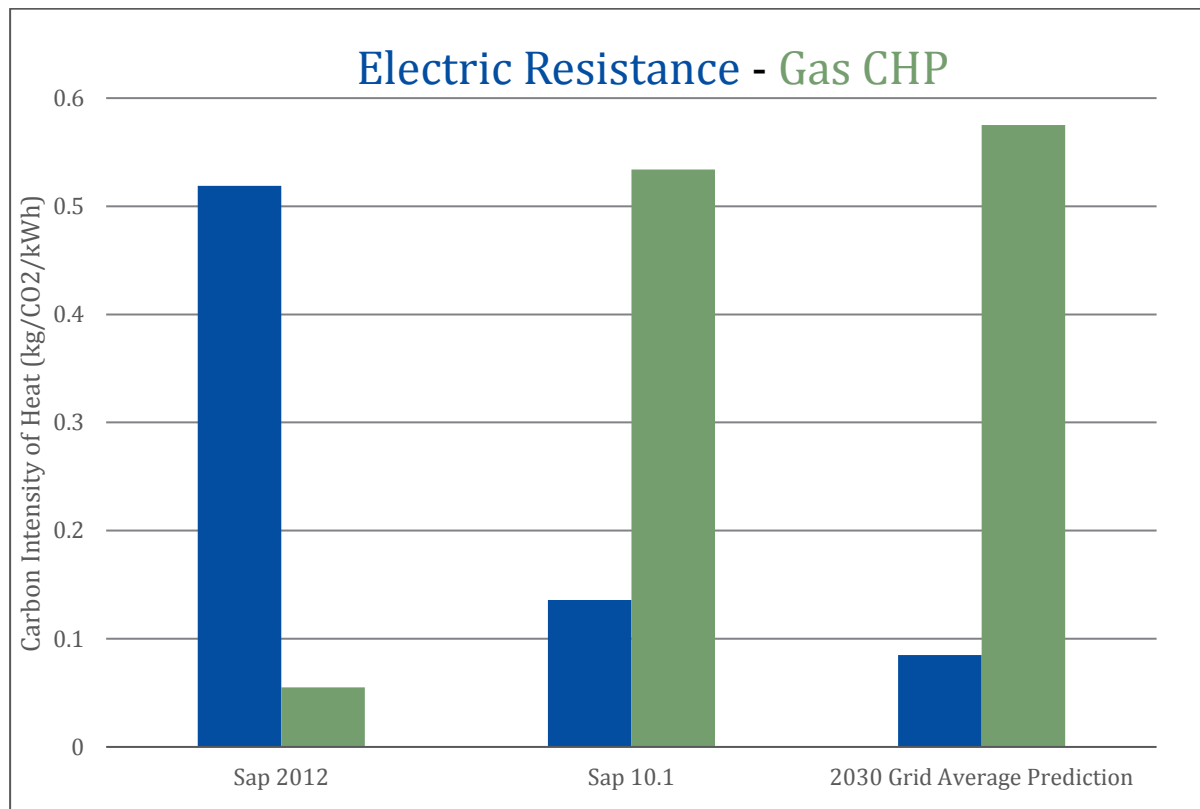


Figure 4: Future Carbon Reductions

- 5.9** It is estimated that an electric resistance heating strategy would result in Day 1 carbon savings of approximately 75% when compared to a gas CHP strategy, savings achieving 84% by 2030 due to continued grid decarbonisation.
- 5.10** An electric heating strategy will also eliminate distribution losses, which are a significant challenge with current heat networks.
- 5.11** Finally, the move away from the complexity of a site-wide heat network will result in significantly lower costs for capital replacement, maintenance, management, metering, and billing of the network. In addition, the high standards of energy efficiency proposed will keep variable costs for heat low.
- 5.12** It is understood that there is sufficient capacity in the local electricity infrastructure to address this electrical demand. 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.
- 5.13** It is therefore proposed that the Vastern Road development incorporates electric heating, via room heaters and an immersion cylinder, to each flat. This is to ensure long-term CO₂ reductions, operational reliability, and cost predictability.

6. RENEWABLE ENERGY TECHNOLOGIES

- 6.1 As shown in Tables 4 and 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 51.9% 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.

Air & Ground Source Heat Pumps (ASHPs & GSHPs)

- 6.3 ASHPs 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.
- 6.4 GSHPs perform a similar action, taking stored heat from the ground instead of the external air. On concentrated development sites such as this, GSHPs are likely to require expensive boreholes to be dug.
- 6.5 ASHPs would be the more suitable heat pump application for the site, however the running costs associated with these systems compare poorly against direct electric heaters when all constituent costs are considered (maintenance, capital replacement, and metering/billing), and not just the unit rate (p/kWh).

Photovoltaic (PV) Panels

- 6.6 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.
- 6.7 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 ~70kWp of PV generating capacity can be provided when using a panel output of 320Wp. 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.
- 6.8 Tables 5 below, details the Regulated CO₂ emissions for the development after the addition 70kWp of PV panels.

Full Development (kg CO ₂ per annum)	
	Regulated Emissions
Baseline	206,400
After <i>Energy Efficiency Measures</i>	101,700
After <i>Renewable Measures</i>	94,500
Total % Savings (On-site)	54.2%

Table 5: Renewable Reduction CO₂

7. ZERO CARBON – POLICY H5C

- 7.1** The Vastern Road energy strategy has demonstrated a reduction in Regulated CO₂ emissions of 55.3% 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 5, a total of 92.5 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:
- > 94.5 tonnes of CO₂ x £60 = £5,670
 - > £5,670 x 30-year period = **£170,100.**
- 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 to all blocks with the exception of one, providing heat recovery & cooling whilst contributing further to the overall CO₂ reduction of the development;
 - > Efficient & simple systems for residents to use;
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 - > Greater tariff flexibility for residents to reduce their heating costs;
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- 8.3** The development proposes to supply heat from 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 **54.2%** reduction in Regulated CO₂ emissions. This goes significantly 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 £170,100.

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APPENDICES

Appendix A

SAP 10.1 Calculations

Appendix B

TER Worksheets for Representative Dwellings

Appendix C

DER Worksheets for Representative Dwellings

Appendix D

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)	
	Space Heating	Hot Water	Regulated Electrical	Unregulated Appliances & Cooking	TFEE	DFEE	TER	DER	TER	DER
B-1B-MF-SE	839	1,432	332	1,258	34.3	34.1	14.39	7.03	27.37	20.01
B-2B-MF-NW	1,437	1,642	457	1,768	42.1	37.7	14.33	6.80	27.30	19.78
A-2B-MF-NW	2,128	1,642	382	1,768	42.1	37.7	13.95	7.98	26.92	20.96
B-2B-TF-SW	1,988	1,573	419	1,587	59.6	48.1	17.89	8.53	30.86	21.50
C-2B-GF-NENW	2,306	1,570	418	1,579	65.8	53.8	19.02	9.24	32.00	22.22
D-2B-ExFI-SE	1,910	1,599	456	1,652	52.3	45.7	16.52	8.16	29.50	21.13
E-1B-Ter-SWNNW	1,609	1,435	324	1,267	61.8	49.1	19.40	9.04	32.37	22.02

Energy Demands & CO₂ Emissions - Vastern Road SAP 10.1 Emission Factors

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	Regulated Electrical	Unregulated Appliances & Cooking	TFEE	DFEE	TER	DER	TER	DER
B-1B-MF-SE	50	47	39,450	67,285	15,582	59,126	81,121	80,648	34,039	16,635	64,726	47,322
B-2B-MF-NW	71	41	58,936	67,336	18,735	72,488	122,070	109,312	41,536	19,721	79,157	57,342
A-2B-MF-NW	71	27	57,457	44,343	10,307	47,736	80,387	71,986	26,636	15,247	51,411	40,022
B-2B-TF-SW	63	35	69,580	55,054	14,676	55,536	132,398	106,852	39,740	18,946	68,563	47,769
C-2B-GF-NENW	63	25	57,650	39,248	10,443	39,481	103,915	84,964	30,040	14,598	50,531	35,089
D-2B-ExFI-SE	66	18	34,380	28,783	8,201	29,741	62,217	54,366	19,657	9,705	35,092	25,141
E-1B-Ter-SWNNW	51	15	24,142	21,530	4,856	18,998	46,962	37,311	14,740	6,872	24,600	16,731
TOTAL (Residential)			341,595	323,579	82,799	323,106	629,070	545,438	206,387	101,724	374,079	269,416
Area Weighted Average (/m²)							48.7	42.2	16.0	7.9	28.9	20.8
Improvement over Target							13.3%		50.7%		28.0%	

Appendix B

TER Worksheets for Representative Dwellings

TER Worksheet Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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, q50, 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)

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	0.93	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	0.39	0.38	0.37	0.34	0.33	0.29	0.29	0.28	0.31	0.33	0.34	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)
--	--

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 (24d)
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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 (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	k-value, kJ/m ² .K	A x k, kJ/K
Door			1.98	x 1.00	= 1.98 (26)		
Window			7.09	x 1.33	= 9.40 (27)		
External wall			32.93	x 0.18	= 5.93 (29a)		
Party wall			43.20	x 0.00	= 0.00 (32)		
Total area of external elements ΣA, m ²			42.00 (31)				

Fabric heat loss, W/K = Σ(A x U) (26)...(30) + (32) = (33)

Heat capacity Cm = Σ(A x k) (28)...(30) + (32) + (32a)...(32e) = (34)

Thermal mass parameter (TMP) in kJ/m²K (35)

Thermal bridges: Σ(L x Ψ) calculated using Appendix K (36)

Total fabric heat loss (33) + (36) = (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)	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)
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4. Water heating energy requirement

Assumed occupancy, N	1.70 (42)
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Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	74.56 (43)
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	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	82.02	79.04	76.06	73.07	70.09	67.11	67.11	70.09	73.07	76.06	79.04	82.02
Σ(44)1...12 =	894.76 (44)											

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	121.63	106.38	109.78	95.71	91.83	79.24	73.43	84.26	85.27	99.37	108.47	117.80
Σ(45)1...12 =	1173.18 (45)											

Distribution loss 0.15 x (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)
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Storage volume (litres) including any solar or WWHRs storage within same vessel	145.00 (47)
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Water storage loss:	1.37 (48)
a) If manufacturer's declared loss factor is known (kWh/day)	0.54 (49)

Temperature factor from Table 2b	0.74 (50)
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Energy lost from water storage (kWh/day) (48) x (49)	0.74 (55)
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Enter (50) or (54) in (55)

0.74

(55)

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

22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87
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(56)

If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)	22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87 (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)	
Combi loss for each month from Table 3a, 3b or 3c													
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m													
167.77	148.05	155.91	140.35	137.97	123.89	119.57	130.40	129.92	145.51	153.12	163.93	(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													
167.77	148.05	155.91	140.35	137.97	123.89	119.57	130.40	129.92	145.51	153.12	163.93		
											$\Sigma(64)1...12 =$	1716.40	(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]													
77.35	68.71	73.41	67.54	67.44	62.07	61.33	64.93	64.07	69.95	71.79	76.08	(65)	

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)
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)
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)
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)
Water heating gains (Table 5)												
103.97	102.25	98.67	93.81	90.65	86.20	82.43	87.27	88.99	94.02	99.70	102.25	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
317.67	315.90	306.11	290.52	275.01	259.88	249.96	254.85	262.79	278.54	296.58	309.81	(73)

6. Solar gains												
	Access factor Table 6d	Area m²	Solar flux W/m²		g specific data or Table 6b	FF specific data or Table 6c	Gains W					
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)
Total gains - internal and solar (73)m + (83)m												
397.39	451.70	491.92	520.75	532.88	515.89	496.78	481.04	463.98	428.63	392.08	378.04	(84)

7. Mean internal temperature (heating season)												
Temperature during heating periods in the living area from Table 9, Th1(°C)											21.00	(85)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains for living area n1,m (see Table 9a)												
0.99	0.98	0.95	0.89	0.75	0.56	0.40	0.43	0.66	0.90	0.98	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)												
20.24	20.39	20.60	20.81	20.94	20.99	21.00	21.00	20.98	20.82	20.50	20.21	(87)

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	0.94	0.86	0.70	0.49	0.33	0.35	0.59	0.87	0.97	0.99	(89)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
19.14	19.36	19.65	19.95	20.11	20.16	20.16	20.17	20.15	19.96	19.52	19.10	(90)	
Living area fraction											Living area ÷ (4) =	0.49	(91)
Mean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2													
19.68	19.87	20.11	20.37	20.52	20.57	20.57	20.57	20.55	20.38	20.00	19.64	(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
19.68	19.87	20.11	20.37	20.52	20.57	20.57	20.57	20.55	20.38	20.00	19.64	(93)	

8. Space heating requirement													
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains, ηm													
0.99	0.97	0.94	0.86	0.72	0.52	0.36	0.39	0.62	0.88	0.97	0.99	(94)	
Useful gains, ηmGm, W (94)m x (84)m													
392.24	439.52	463.22	450.36	383.94	268.77	180.40	188.95	287.78	376.55	380.81	374.21	(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]													
722.89	701.56	636.22	529.00	405.61	271.31	180.63	189.33	294.82	450.08	596.35	717.98	(97)	
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
246.00	176.09	128.71	56.62	16.12	0.00	0.00	0.00	0.00	54.70	155.19	255.76		
											$\Sigma(98)1...5, 10...12 =$	1089.21	(98)
Space heating requirement kWh/m²/year											(98) ÷ (4)	21.65	(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													
263.11	188.33	137.66	60.56	17.24	0.00	0.00	0.00	0.00	58.50	165.98	273.54		
											$\Sigma(211)1...5, 10...12 =$	1164.93	(211)

Water heating													
Efficiency of water heater													
85.83	85.28	84.31	82.61	80.80	79.80	79.80	79.80	79.80	82.46	84.85	86.00	(217)	
Water heating fuel, kWh/month													
195.46	173.61	184.93	169.90	170.75	155.25	149.83	163.41	162.80	176.45	180.46	190.63		
											$\Sigma(219a)1...12 =$	2073.51	(219)

Annual totals												
Space heating fuel - main system 1											1164.93	
Water heating fuel											2073.51	

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) = 3563.19 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1164.93	x	3.48	x 0.01 =	40.54	(240)
Water heating	2073.51	x	3.48	x 0.01 =	72.16	(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) =	275.53	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.21	(257)
SAP value	83.06	
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	1164.93	x	0.216	=	251.62	(261)
Water heating	2073.51	x	0.216	=	447.88	(264)
Space and water heating			(261) + (262) + (263) + (264) =		699.50	(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) =		868.05	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		24.90	(273)
EI value					87.80	
EI rating (section 14)					88	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1164.93	x	1.22	=	1421.21	(261)
Water heating	2073.51	x	1.22	=	2529.69	(264)
Space and water heating			(261) + (262) + (263) + (264) =		3950.90	(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					4947.87	(272)
Dwelling primary energy rate kWh/m ² /year					98.33	(273)

TER Worksheet Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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)

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)
--	------	------	------	------	------	------	------	------	------	------	------	------	-------

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)
--	------	------	------	------	------	------	------	------	------	------	------	------	-------

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)
--	------	------	------	------	------	------	------	------	------	------	------	------	------

3. Heat losses and heat loss parameter

Element	Gross area, m²	Openings m²	Net area A, m²	U-value W/m²K	A x U W/K	κ-value, kJ/m².K	A x κ, kJ/K
Door			1.98	x 1.00	= 1.98		(26)
Window			9.12	x 1.33	= 12.09		(27)
External wall			49.80	x 0.18	= 8.96		(29a)
Party wall			41.40	x 0.00	= 0.00		(32)
Total area of external elements ΣA, m²			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/m²K						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
37.21	37.01	36.82	35.90	35.73	34.93	34.93	34.78	35.24	35.73	36.08	36.44

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

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00

4. Water heating energy requirement

Assumed occupancy, N	2.26
Annual average hot water usage in litres per day Vd,average = (25 × N) + 36	87.96

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

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

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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	145.00
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Water storage loss:	
a) If manufacturer's declared loss factor is known (kWh/day)	1.37
Temperature factor from Table 2b	0.54
Energy lost from water storage (kWh/day) (48) × (49)	0.74
Enter (50) or (54) in (55)	0.74

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87

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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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
------	------	------	------	------	------	------	------	------	------	------	------

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

189.62	167.16	175.63	157.55	154.46	138.13	132.76	145.54	145.24	163.36	172.61	185.09
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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
------	------	------	------	------	------	------	------	------	------	------	------

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

189.62	167.16	175.63	157.55	154.46	138.13	132.76	145.54	145.24	163.36	172.61	185.09
Σ(64)1...12 =											1927.14

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

84.62	75.06	79.97	73.26	72.93	66.80	65.71	69.96	69.16	75.89	78.27	83.11
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17	113.17

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
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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
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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
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54	-90.54

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
113.73	111.70	107.48	101.75	98.02	92.78	88.32	94.03	96.06	102.00	108.70	111.71

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
392.03	389.90	377.26	357.05	336.67	317.05	304.35	310.17	320.61	341.03	364.39	381.77

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
0.77	x 9.12	x 11.28	x 0.9 x 0.63	x 0.70	= 31.45

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
31.45	64.01	115.33	189.41	254.60	271.43	253.92	202.43	140.53	78.23	39.57	25.68

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
423.48	453.91	492.59	546.46	591.27	588.48	558.27	512.59	461.14	419.25	403.96	407.45

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)	21.00
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.00	1.00	0.99	0.96	0.86	0.66	0.49	0.56	0.84	0.98	1.00	1.00

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
20.08	20.18	20.38	20.66	20.88	20.98	21.00	21.00	20.93	20.65	20.32	20.06

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	0.95	0.82	0.59	0.40	0.46	0.77	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)

18.91	19.06	19.35	19.76	20.05	20.17	20.18	20.18	20.12	19.75	19.28	18.90	(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

19.48	19.60	19.84	20.19	20.46	20.56	20.57	20.57	20.51	20.19	19.78	19.46	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.48	19.60	19.84	20.19	20.46	20.56	20.57	20.57	20.51	20.19	19.78	19.46	(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	0.99	0.99	0.95	0.83	0.62	0.45	0.51	0.80	0.97	0.99	1.00	(94)

Useful gains, ηmGm, W (94)m x (84)m

422.01	451.23	485.40	518.27	492.54	365.77	248.57	259.43	368.29	405.18	401.09	406.32	(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]

987.67	953.75	863.16	720.10	556.84	374.29	249.49	261.38	404.47	609.65	811.08	981.43	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

420.85	337.69	281.06	145.32	47.84	0.00	0.00	0.00	0.00	152.13	295.19	427.88	
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Σ(98)1...5, 10...12 = 2107.94 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 29.81 (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												
450.10	361.17	300.60	155.42	51.16	0.00	0.00	0.00	0.00	162.70	315.71	457.63	
Σ(211)1...5, 10...12 =												2254.49 (211)

Water heating

Efficiency of water heater

86.88	86.65	86.06	84.60	82.10	79.80	79.80	79.80	79.80	84.62	86.23	86.98
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 (217)

Water heating fuel, kWh/month

218.25	192.91	204.08	186.23	188.15	173.09	166.36	182.38	182.00	193.04	200.16	212.80	
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Σ(219a)1...12 = 2299.45 (219)

Annual totals

Space heating fuel - main system 1 2254.49
Water heating fuel 2299.45

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) = 4971.15	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2254.49	x	3.48	x 0.01 =	78.46	(240)
Water heating	2299.45	x	3.48	x 0.01 =	80.02	(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) =	333.51	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.21	(257)
SAP value	83.11	
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	2254.49	x	0.216	=	486.97	(261)
Water heating	2299.45	x	0.216	=	496.68	(264)
Space and water heating				(261) + (262) + (263) + (264) =	983.65	(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) =	1200.18	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	24.62	(273)
EI value					86.10	
EI rating (section 14)					86	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2254.49	x	1.22	=	2750.47	(261)
Water heating	2299.45	x	1.22	=	2805.33	(264)
Space and water heating				(261) + (262) + (263) + (264) =	5555.81	(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					6836.63	(272)
Dwelling primary energy rate kWh/m2/year					96.67	(273)

TER Worksheet Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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, q50, 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)

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
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	0.93	1.00	1.08	1.13	1.18
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 (22a)

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
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 (22b)

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
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 (24d)

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
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 (25)

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	k-value, kJ/m ² .K	A x k, 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 0.18	= 8.96		(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 x U) (26)...(30) + (32) = (33)

Heat capacity Cm = Σ(A x k) (28)...(30) + (32) + (32a)...(32e) = (34)

Thermal mass parameter (TMP) in kJ/m²K (35)

Thermal bridges: Σ(L x Ψ) calculated using Appendix K (36)

Total fabric heat loss (33) + (36) = (37)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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 = $\sum(39)1...12/12 =$											63.77	(39)

Heat loss parameter (HLP), W/m²K (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 = $\sum(40)1...12/12 =$											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
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 (40)

4. Water heating energy requirement

Assumed occupancy, N (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 (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
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 (46)

Storage volume (litres) including any solar or WWHRs storage within same vessel (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day) (48)

Temperature factor from Table 2b (49)

Energy lost from water storage (kWh/day) (48) x (49) (50)

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

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

22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87
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 (56)

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

22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87
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 (57)

Primary circuit loss for each month from Table 3

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)	
Combi loss for each month from Table 3a, 3b or 3c													
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m													
189.62	167.16	175.63	157.55	154.46	138.13	132.76	145.54	145.24	163.36	172.61	185.09	(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													
189.62	167.16	175.63	157.55	154.46	138.13	132.76	145.54	145.24	163.36	172.61	185.09		
											Σ(64)1...12 =	1927.14	(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]													
84.62	75.06	79.97	73.26	72.93	66.80	65.71	69.96	69.16	75.89	78.27	83.11	(65)	

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)
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)
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)
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)												
-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)												
113.73	111.70	107.48	101.75	98.02	92.78	88.32	94.03	96.06	102.00	108.70	111.71	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
392.03	389.90	377.26	357.05	336.67	317.05	304.35	310.17	320.61	341.03	364.39	381.77	(73)

6. Solar gains												
	Access factor Table 6d	Area m²	Solar flux W/m²		g specific data or Table 6b	FF specific data or Table 6c	Gains W					
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 Σ(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)
Total gains - internal and solar (73)m + (83)m												
423.48	453.91	492.59	546.46	591.27	588.48	558.27	512.59	461.14	419.25	403.96	407.45	(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	1.00	0.99	0.96	0.86	0.66	0.49	0.56	0.84	0.98	1.00	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)												
20.08	20.18	20.38	20.66	20.88	20.98	21.00	21.00	20.93	20.65	20.32	20.06	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)													
20.15	20.15	20.16	20.17	20.17	20.18	20.18	20.18	20.17	20.17	20.16	20.16	(88)	
Utilisation factor for gains for rest of dwelling n2,m													
1.00	1.00	0.99	0.95	0.82	0.59	0.40	0.46	0.77	0.97	0.99	1.00	(89)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
18.91	19.06	19.35	19.76	20.05	20.17	20.18	20.18	20.12	19.75	19.28	18.90	(90)	
Living area fraction											Living area ÷ (4) =	0.48	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
19.48	19.60	19.84	20.19	20.46	20.56	20.57	20.57	20.51	20.19	19.78	19.46	(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
19.48	19.60	19.84	20.19	20.46	20.56	20.57	20.57	20.51	20.19	19.78	19.46	(93)	

8. Space heating requirement													
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains, ηm													
1.00	0.99	0.99	0.95	0.83	0.62	0.45	0.51	0.80	0.97	0.99	1.00	(94)	
Useful gains, ηmGm, W (94)m x (84)m													
422.01	451.23	485.40	518.27	492.54	365.77	248.57	259.43	368.29	405.18	401.09	406.32	(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]													
987.67	953.75	863.16	720.10	556.84	374.29	249.49	261.38	404.47	609.65	811.08	981.43	(97)	
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
420.85	337.69	281.06	145.32	47.84	0.00	0.00	0.00	0.00	152.13	295.19	427.88		
											Σ(98)1...5, 10...12 =	2107.94	(98)
Space heating requirement kWh/m²/year											(98) ÷ (4)	29.81	(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													
450.10	361.17	300.60	155.42	51.16	0.00	0.00	0.00	0.00	162.70	315.71	457.63		
											Σ(211)1...5, 10...12 =	2254.49	(211)

Water heating													
Efficiency of water heater													
86.88	86.65	86.06	84.60	82.10	79.80	79.80	79.80	79.80	84.62	86.23	86.98	(217)	
Water heating fuel, kWh/month													
218.25	192.91	204.08	186.23	188.15	173.09	166.36	182.38	182.00	193.04	200.16	212.80		
											Σ(219a)1...12 =	2299.45	(219)

Annual totals												
Space heating fuel - main system 1											2254.49	
Water heating fuel											2299.45	

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) = 4971.15	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2254.49	x	3.48	x 0.01 =	78.46	(240)
Water heating	2299.45	x	3.48	x 0.01 =	80.02	(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) =	333.51	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.21	(257)
SAP value	83.11	
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	2254.49	x	0.216	=	486.97	(261)
Water heating	2299.45	x	0.216	=	496.68	(264)
Space and water heating			(261) + (262) + (263) + (264) =		983.65	(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) =		1200.18	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		24.62	(273)
EI value					86.10	
EI rating (section 14)					86	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2254.49	x	1.22	=	2750.47	(261)
Water heating	2299.45	x	1.22	=	2805.33	(264)
Space and water heating			(261) + (262) + (263) + (264) =		5555.81	(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					6836.63	(272)
Dwelling primary energy rate kWh/m ² /year					96.67	(273)

TER Worksheet Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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	$\div (5) =$	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 Vd,average = (25 x 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 Vd,m = factor from Table 1c x (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		
	Σ(44)1...12 = 1002.59												(44)	
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/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		
	Σ(45)1...12 = 1314.55												(45)	
Distribution loss 0.15 x (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													145.00	(47)
Water storage loss:														
a) If manufacturer's declared loss factor is known (kWh/day)													1.37	(48)
Temperature factor from Table 2b													0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)													0.74	(50)
Enter (50) or (54) in (55)													0.74	(55)
Water storage loss calculated for each month (55) x (41)m	22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87	(57)	

Primary circuit loss for each month from Table 3

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Combi loss for each month from Table 3a, 3b or 3c												
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month $0.85 \times (45)m + (46)m + (57)m + (59)m + (61)m$												
182.43	160.87	169.14	151.89	149.03	133.44	128.42	140.55	140.19	157.49	166.19	178.13	(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) $(62)m + (63)m$												
182.43	160.87	169.14	151.89	149.03	133.44	128.42	140.55	140.19	157.49	166.19	178.13	
												$\Sigma(64)1...12 =$ 1857.78 (64)
Heat gains from water heating (kWh/month) $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$												
82.23	72.97	77.81	71.38	71.12	65.24	64.27	68.30	67.49	73.93	76.13	80.80	(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)	110.52	108.59	104.58	99.13	95.60	90.61	86.38	91.81	93.73	99.37	105.74	108.60	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	365.71	363.83	352.35	333.91	315.34	297.32	285.53	290.91	300.31	318.94	340.33	356.23	(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	x 12.00	x 36.79	x 0.9 x 0.63	x 0.70	= 134.94 (79)						
Solar gains in watts Σ(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												
	500.64	593.67	666.83	723.57	751.80	730.62	703.28	673.75	640.83	572.97	501.96	471.71 (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	0.84	0.68	0.51	0.55	0.78	0.94	0.99	1.00		(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													

	19.65	19.85	20.14	20.48	20.77	20.94	20.99	20.98	20.88	20.51	20.01	19.61	(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	0.90	0.78	0.58	0.38	0.42	0.69	0.92	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
	18.03	18.33	18.74	19.22	19.59	19.78	19.81	19.81	19.72	19.27	18.56	17.98	(90)
Living area fraction										Living area ÷ (4) =		0.42	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
	18.71	18.97	19.33	19.75	20.09	20.26	20.31	20.30	20.21	19.79	19.17	18.67	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
	18.71	18.97	19.33	19.75	20.09	20.26	20.31	20.30	20.21	19.79	19.17	18.67	(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	0.90	0.80	0.62	0.44	0.48	0.72	0.92	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m													
	495.18	580.42	636.38	652.11	597.74	451.03	308.41	322.30	462.04	526.10	491.22	467.64	(95)
Monthly average external temperature from Table U1													
	4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]													
	1246.78	1214.58	1105.34	926.46	714.44	478.59	313.11	329.23	517.79	782.90	1032.23	1241.68	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
	559.19	426.16	348.91	197.53	86.83	0.00	0.00	0.00	0.00	191.06	389.53	575.88	
										Σ(98)1...5, 10...12 =		2775.08	(98)
Space heating requirement kWh/m²/year										(98) ÷ (4) =		43.72	(99)

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

Space heating													
Fraction of space heat from secondary/supplementary system (table 11)										0.00		(201)	
Fraction of space heat from main system(s)										1 - (201) =		1.00	(202)
Fraction of space heat from main system 2										0.00		(202)	
Fraction of total space heat from main system 1										(202) x [1- (203)] =		1.00	(204)
Fraction of total space heat from main system 2										(202) x (203) =		0.00	(205)
Efficiency of main system 1 (%)										93.50		(206)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month													
	598.06	455.78	373.16	211.26	92.86	0.00	0.00	0.00	0.00	204.35	416.61	615.92	
										Σ(211)1...5, 10...12 =		2968.00	(211)

Water heating													
Efficiency of water heater													
	87.61	87.29	86.70	85.52	83.43	79.80	79.80	79.80	79.80	85.33	87.01	87.72	(217)
Water heating fuel, kWh/month													
	208.23	184.29	195.08	177.61	178.63	167.22	160.92	176.13	175.68	184.56	191.00	203.06	
										Σ(219a)1...12 =		2202.43	(219)

Annual totals													
Space heating fuel - main system 1										2968.00			

Water heating fuel		2202.43	
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) =	5535.34 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2968.00	x	3.48	x 0.01 =	103.29	(240)
Water heating	2202.43	x	3.48	x 0.01 =	76.64	(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) =	348.06 (255)

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

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)		1.35	(257)
SAP value		81.20	
SAP rating (section 13)		81	(258)
SAP band		B	

12a. 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	2968.00	x	0.216	=	641.09	(261)
Water heating	2202.43	x	0.216	=	475.72	(264)
Space and water heating					(261) + (262) + (263) + (264) =	1116.81 (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) =	1306.20 (272)
Dwelling CO ₂ emission rate					(272) ÷ (4) =	30.26 (273)
EI value					83.86	
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	2968.00	x	1.22	=	3620.96	(261)
Water heating	2202.43	x	1.22	=	2686.96	(264)
Space and water heating					(261) + (262) + (263) + (264) =	6307.92 (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					7428.19	(272)
Dwelling primary energy rate kWh/m2/year					117.03	(273)

TER Worksheet

Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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, q50, 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)

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
5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

Monthly average wind speed from Table U2

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	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

	0.40	0.39	0.38	0.34	0.33	0.29	0.29	0.31	0.33	0.35	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)
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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	0.57
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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	0.57
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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	k-value, kJ/m ² .K	A x k, kJ/K
Door			1.98	1.00	1.98		(26)
Window			11.80	1.33	15.64		(27)
Ground floor			63.17	0.13	8.21		(28a)
External wall			82.52	0.18	14.85		(29a)
Total area of external elements ΣA, m ²			159.47				(31)

Fabric heat loss, W/K = Σ(A x U) (26)...(30) + (32) = 40.69 (33)

Heat capacity Cm = Σ(A x k) (28)...(30) + (32) + (32a)...(32e) = N/A (34)

Thermal mass parameter (TMP) in kJ/m²K 250.00 (35)

Thermal bridges: Σ(L x 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
33.15	32.98	32.81	32.00	31.85	31.16	31.16	31.03	31.42	31.85	32.16	32.48

Ventilation heat loss calculated monthly 0.33 x (25)m x (5) 84.16 83.99 83.81 83.01 82.86 82.16 82.16 82.03 82.43 82.86 83.17 83.48 (38)

Heat transfer coefficient, W/K (37)m + (38)m

Average = Σ(39)1...12/12 = 83.01 (39)

Heat loss parameter (HLP), W/m²K (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
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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
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4. Water heating energy requirement

Assumed occupancy, N 2.07 (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 83.36 (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
91.69	88.36	85.02	81.69	78.35	75.02	75.02	78.35	81.69	85.02	88.36	91.69

Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)

Σ(44)1...12 = 1000.26 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/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
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Σ(45)1...12 = 1311.50 (45)

Distribution loss 0.15 x (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
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Storage volume (litres) including any solar or WWHRS storage within same vessel 145.00 (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day) 1.37 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage (kWh/day) (48) x (49) 0.74 (50)

Enter (50) or (54) in (55) 0.74 (55)

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

22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)

22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87
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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)
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m												
182.11	160.60	168.86	151.64	148.80	133.24	128.23	140.34	139.97	157.23	165.91	177.82	(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												
182.11	160.60	168.86	151.64	148.80	133.24	128.23	140.34	139.97	157.23	165.91	177.82	
$\Sigma(64)1...12 =$											1854.73	(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]												
82.12	72.88	77.71	71.29	71.04	65.17	64.20	68.23	67.41	73.85	76.04	80.69	(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)
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)												
110.38	108.45	104.45	99.02	95.49	90.52	86.30	91.71	93.63	99.26	105.61	108.46	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
364.67	362.79	351.34	332.96	314.46	296.51	284.76	290.12	299.49	318.06	339.38	355.22	(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		
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)
Total gains - internal and solar (73)m + (83)m													
	405.35	445.61	500.56	578.03	643.88	647.70	613.29	552.03	481.32	419.28	390.58	388.45	(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	1.00	0.99	0.96	0.88	0.73	0.57	0.64	0.88	0.98	1.00	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)												

19.56	19.69	19.96	20.35	20.71	20.92	20.98	20.97	20.79	20.35	19.89	19.54	(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	0.98	0.95	0.84	0.63	0.43	0.50	0.81	0.97	0.99	1.00	(89)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
17.91	18.11	18.50	19.07	19.55	19.79	19.83	19.83	19.66	19.07	18.41	17.89	(90)	
Living area fraction										Living area ÷ (4) =		0.31	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
18.42	18.59	18.95	19.46	19.90	20.13	20.18	20.18	20.01	19.46	18.86	18.39	(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
18.42	18.59	18.95	19.46	19.90	20.13	20.18	20.18	20.01	19.46	18.86	18.39	(93)	

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, η_m													
	0.99	0.99	0.98	0.94	0.84	0.65	0.47	0.54	0.82	0.96	0.99	1.00	(94)
Useful gains, $\eta_m G_m$, W (94)m x (84)m													
	403.18	441.69	490.76	544.79	541.24	423.29	288.99	299.64	396.88	404.41	386.85	386.73	(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, L_m , W [(39)m x [(93)m - (96)m]													
	1188.18	1150.10	1043.57	876.90	679.69	454.68	294.48	309.77	487.06	734.46	978.38	1184.83	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
	584.05	476.05	411.29	239.12	103.01	0.00	0.00	0.00	0.00	245.56	425.90	593.79	
	$\Sigma(98)1...5, 10...12 =$										3078.76	(98)	
Space heating requirement kWh/m ² /year											(98) ÷ (4)	48.74	(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												
624.65	509.14	439.88	255.74	110.17	0.00	0.00	0.00	0.00	262.64	455.51	635.07	
$\Sigma(211)1...5, 10...12 =$											3292.80	(211)

Water heating

Efficiency of water heater												
87.70	87.54	87.10	86.02	83.86	79.80	79.80	79.80	79.80	86.00	87.22	87.79	(217)
Water heating fuel, kWh/month												
207.64	183.46	193.86	176.28	177.44	166.96	160.68	175.86	175.40	182.82	190.22	202.56	
$\Sigma(219a)1...12 =$											2193.19	(219)

Annual totals

Space heating fuel - main system 1	3292.80
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Water heating fuel				2193.19	
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) =			5850.20	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	3292.80	x	3.48	x 0.01 =	114.59	(240)
Water heating	2193.19	x	3.48	x 0.01 =	76.32	(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) =	358.95	(255)

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

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)		1.39	(257)
SAP value		80.56	
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	3292.80	x	0.216	=	711.24	(261)
Water heating	2193.19	x	0.216	=	473.73	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1184.97	(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) =		1374.00	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		32.07	(273)
EI value					82.98	
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	3292.80	x	1.22	=	4017.21	(261)
Water heating	2193.19	x	1.22	=	2675.70	(264)
Space and water heating			(261) + (262) + (263) + (264) =		6692.91	(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					7811.04	(272)
Dwelling primary energy rate kWh/m ² /year					123.65	(273)

TER Worksheet Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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)

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 20	÷ (5) =	0.11	(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	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)
--	------	------	------	------	------	------	------	------	------	------	------	------	-------

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

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

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

	0.56	0.56	0.56	0.55	0.54	0.54	0.54	0.53	0.54	0.54	0.55	0.55	(25)
--	------	------	------	------	------	------	------	------	------	------	------	------	------

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 Vd,average = (25 x 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 Vd,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		
	Σ(44)1...12 =												1022.46	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/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		
	Σ(45)1...12 =												1340.61	(45)
Distribution loss 0.15 x (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													145.00	(47)
Water storage loss:														
a) If manufacturer's declared loss factor is known (kWh/day)													1.37	(48)
Temperature factor from Table 2b													0.54	(49)
Energy lost from water storage (kWh/day) (48) x (49)													0.74	(50)
Enter (50) or (54) in (55)													0.74	(55)
Water storage loss calculated for each month (55) x (41)m														
	22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)														
	22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87	(57)	

Primary circuit loss for each month from Table 3

23.26	21.01	23.26	22.51	23.26	22.51	23.26	23.26	22.51	23.26	22.51	23.26	(59)
Combi loss for each month from Table 3a, 3b or 3c												
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m												
185.13	163.24	171.58	154.01	151.07	135.20	130.05	142.43	142.09	159.69	168.60	180.74	(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												
185.13	163.24	171.58	154.01	151.07	135.20	130.05	142.43	142.09	159.69	168.60	180.74	
											Σ(64)1...12 =	1883.84 (64)
Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]												
83.12	73.76	78.62	72.08	71.80	65.83	64.81	68.93	68.12	74.67	76.93	81.67	(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	(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	(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	(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)	111.73	109.76	105.67	100.11	96.51	91.43	87.11	92.64	94.61	100.36	106.85	109.77	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	376.43	374.35	362.28	343.01	323.64	304.97	292.87	298.52	308.46	327.93	350.18	366.69	(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							
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	(83)
Total gains - internal and solar (73)m + (83)m													
	468.19	530.64	576.13	607.98	620.43	599.61	576.94	558.85	540.02	500.66	460.09	445.22	(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	0.95	0.88	0.73	0.56	0.60	0.82	0.96	0.99	1.00	(86)	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													

	19.84	19.99	20.22	20.52	20.78	20.94	20.99	20.98	20.89	20.56	20.14	19.81	(87)	
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)	
Utilisation factor for gains for rest of dwelling n2,m														
	0.99	0.99	0.98	0.94	0.84	0.64	0.44	0.47	0.74	0.94	0.99	1.00	(89)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)														
	18.41	18.64	18.97	19.39	19.74	19.93	19.96	19.96	19.88	19.46	18.87	18.37	(90)	
Living area fraction											Living area ÷ (4) =		0.43	(91)
Mean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2														
	19.02	19.22	19.51	19.87	20.18	20.36	20.40	20.40	20.31	19.93	19.41	18.99	(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate														
	19.02	19.22	19.51	19.87	20.18	20.36	20.40	20.40	20.31	19.93	19.41	18.99	(93)	

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
	0.99	0.99	0.97	0.94	0.85	0.68	0.49	0.53	0.77	0.94	0.99	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m													
	464.79	523.28	559.81	568.51	526.93	406.76	282.15	294.63	416.38	471.47	453.42	442.65	(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]													
	1133.89	1100.50	998.13	834.58	643.96	433.91	286.38	300.80	469.22	708.58	937.94	1130.34	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
	497.81	387.89	326.11	191.57	87.07	0.00	0.00	0.00	0.00	176.41	348.86	511.64	
	Σ(98)1...5, 10...12 =										2527.36	(98)	
Space heating requirement kWh/m²/year	(98) ÷ (4) =										38.24	(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													
	532.42	414.85	348.78	204.89	93.13	0.00	0.00	0.00	0.00	188.68	373.11	547.21	
	Σ(211)1...5, 10...12 =										2703.06	(211)	

Water heating													
Efficiency of water heater													
	87.33	87.04	86.50	85.40	83.41	79.80	79.80	79.80	79.80	85.08	86.71	87.44	(217)
Water heating fuel, kWh/month													
	212.00	187.53	198.36	180.35	181.13	169.43	162.97	178.48	178.05	187.70	194.44	206.71	
	Σ(219a)1...12 =										2237.15	(219)	

Annual totals													
Space heating fuel - main system 1											2703.06		

Water heating fuel			2237.15	
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) =		5341.69	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2703.06	x	3.48	x 0.01 =	94.07	(240)
Water heating	2237.15	x	3.48	x 0.01 =	77.85	(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) =				344.87	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.30	(257)
SAP value	81.81	
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	2703.06	x	0.216	=	583.86	(261)
Water heating	2237.15	x	0.216	=	483.22	(264)
Space and water heating	(261) + (262) + (263) + (264) =				1067.08	(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) =				1275.45	(272)
Dwelling CO ₂ emission rate	(272) ÷ (4) =				28.18	(273)
EI value					84.62	
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	2703.06	x	1.22	=	3297.73	(261)
Water heating	2237.15	x	1.22	=	2729.32	(264)
Space and water heating	(261) + (262) + (263) + (264) =				6027.05	(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					7259.60	(272)
Dwelling primary energy rate kWh/m2/year					109.84	(273)

TER Worksheet Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
Address	18 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, q50, expressed in cubic metres per hour per square metre of envelope area (17)

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) (18)

Number of sides on which the dwelling is sheltered (19)

Shelter factor 1 - [0.075 x (19)] = (20)

Infiltration rate incorporating shelter factor (18) x (20) = (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	0.93	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	0.43	0.42	0.41	0.37	0.36	0.32	0.32	0.31	0.33	0.36	0.38	0.39 (22b)
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Calculate effective air change rate for the applicable case:

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

If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h (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 (24d)
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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 (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	k-value, kJ/m ² .K	A x k, 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 x U) (26)...(30) + (32) = (33)

Heat capacity Cm = Σ(A x k) (28)...(30) + (32) + (32a)...(32e) = (34)

Thermal mass parameter (TMP) in kJ/m²K (35)

Thermal bridges: Σ(L x Ψ) calculated using Appendix K (36)

Total fabric heat loss (33) + (36) = (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)
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4. Water heating energy requirement

Assumed occupancy, N	1.71 (42)
Annual average hot water usage in litres per day Vd,average = (25 x 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 Vd,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
Σ(44)1...12 =	897.62 (44)											

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/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
Σ(45)1...12 =	1176.92 (45)											

Distribution loss 0.15 x (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)
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Storage volume (litres) including any solar or WWHRS storage within same vessel (47)

Water storage loss:	
a) If manufacturer's declared loss factor is known (kWh/day)	1.37 (48)
Temperature factor from Table 2b	0.54 (49)
Energy lost from water storage (kWh/day) (48) x (49)	0.74 (50)
Enter (50) or (54) in (55)	0.74 (55)

Water storage loss calculated for each month (55) x (41)m	22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87 (56)
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	22.87	20.66	22.87	22.14	22.87	22.14	22.87	22.87	22.14	22.87	22.14	22.87 (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 $0.85 \times (45)\text{m} + (46)\text{m} + (57)\text{m} + (59)\text{m} + (61)\text{m}$

168.16	148.39	156.26	140.66	138.26	124.15	119.80	130.67	130.19	145.83	153.47	164.31	(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) $(62)\text{m} + (63)\text{m}$

168.16	148.39	156.26	140.66	138.26	124.15	119.80	130.67	130.19	145.83	153.47	164.31	
$\Sigma(64)1...12 =$											1720.15	(64)

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

77.48	68.82	73.53	67.64	67.54	62.15	61.40	65.02	64.16	70.06	71.90	76.20	(65)
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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	(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	(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)

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)

-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)

104.14	102.41	98.83	93.95	90.78	86.32	82.53	87.39	89.11	94.16	99.86	102.42	(72)
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Total internal gains $(66)\text{m} + (67)\text{m} + (68)\text{m} + (69)\text{m} + (70)\text{m} + (71)\text{m} + (72)\text{m}$

318.06	316.38	306.69	291.18	275.71	260.57	250.57	255.37	263.20	278.88	296.89	310.13	(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		
SouthWest	0.77	x	6.72	x	36.79	x 0.9 x	0.63	x	0.70	=	75.56	(79)	
NorthWest	0.77	x	3.84	x	11.28	x 0.9 x	0.63	x	0.70	=	13.24	(81)	
Solar gains in watts $\Sigma(74)\text{m}... (82)\text{m}$													
	88.81	155.67	224.67	297.96	351.61	356.93	340.85	299.62	249.86	175.19	107.17	75.48	(83)
Total gains - internal and solar (73)m + (83)m													
	406.86	472.05	531.36	589.14	627.32	617.50	591.42	554.99	513.07	454.08	404.06	385.61	(84)

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	21.00	(85)
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Utilisation factor for gains for living area n1,m (see Table 9a)

0.99	0.99	0.97	0.92	0.82	0.65	0.49	0.54	0.77	0.94	0.99	0.99	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.67	19.86	20.15	20.51	20.79	20.95	20.99	20.98	20.88	20.51	20.02	19.64	(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	0.90	0.76	0.55	0.36	0.41	0.68	0.92	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)

18.06	18.33	18.75	19.26	19.62	19.79	19.82	19.82	19.73	19.28	18.59	18.02	(90)
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Living area fraction Living area ÷ (4) = 0.62 (91)

Mean internal temperature for the whole dwelling $fLA \times T1 + (1 - fLA) \times T2$

19.06	19.28	19.62	20.03	20.35	20.51	20.55	20.54	20.45	20.04	19.48	19.02	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.06	19.28	19.62	20.03	20.35	20.51	20.55	20.54	20.45	20.04	19.48	19.02	(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, η_m	0.99	0.98	0.96	0.90	0.79	0.61	0.44	0.49	0.74	0.93	0.98	0.99	(94)

Useful gains, $\eta_m G_m$, W $(94)\text{m} \times (84)\text{m}$

402.51	462.40	508.79	531.28	493.87	374.64	260.18	270.57	377.19	420.19	395.87	382.29	(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, L_m , W $[(39)\text{m} \times [(93)\text{m} - (96)\text{m}]$

1015.52	987.05	898.25	754.03	584.65	395.58	264.10	276.72	426.37	638.15	840.24	1010.56	(97)
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Space heating requirement, kWh/month $0.024 \times [(97)\text{m} - (95)\text{m}] \times (41)\text{m}$

456.08	352.57	289.76	160.38	67.53	0.00	0.00	0.00	0.00	162.16	319.95	467.44	
$\Sigma(98)1...5, 10...12 =$											2275.87	(98)

Space heating requirement kWh/m²/year (98) ÷ (4) 44.92 (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														
	487.79	377.08	309.90	171.53	72.23	0.00	0.00	0.00	0.00	173.43	342.19	499.93		
	$\sum(211)_{1...5, 10...12} =$												2434.09	(211)

Water heating

Efficiency of water heater	87.35	87.04	86.44	85.16	83.02	79.80	79.80	79.80	79.80	85.10	86.73	87.45	(217)
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Water heating fuel, kWh/month													
192.52	170.48	180.78	165.16	166.54	155.57	150.13	163.75	163.15	171.37	176.95	187.89		
											$\Sigma(219a)1...12 =$	2044.28	(219)

Annual totals

Space heating fuel - main system 1		2434.09	
Water heating fuel		2044.28	
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) =	4788.64	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2434.09	x	3.48	x 0.01 =	84.71	(240)
Water heating	2044.28	x	3.48	x 0.01 =	71.14	(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) =		316.77	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.39	(257)
SAP value	80.60	
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	2434.09	x	0.216	=	525.76	(261)
Water heating	2044.28	x	0.216	=	441.56	(264)
Space and water heating			(261) + (262) + (263) + (264) =		967.33	(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) =		1128.36	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		32.78	(273)
EI value					84.19	
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	2434.09	x	1.22	=	2969.59	(261)
Water heating	2044.28	x	1.22	=	2494.02	(264)
Space and water heating			(261) + (262) + (263) + (264) =		5463.60	(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					6416.16	(272)
Dwelling primary energy rate kWh/m ² /year					126.65	(273)

Appendix C

DER Worksheets for Representative Dwellings

DER Worksheet

Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
Address	18 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	0 x 10 =	0 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)

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

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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
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	0.93	1.00	1.08	1.13	1.18
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 (22a)

Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m

0.20	0.19	0.19	0.17	0.17	0.15	0.15	0.14	0.16	0.17	0.18
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 (22b)

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
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 (24a)

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
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 (25)

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	k-value, kJ/m ² .K	A x k, kJ/K
Door			1.98	x 1.00	= 1.98		(26)
Window			7.09	x 1.33	= 9.40		(27)
External wall			32.93	x 0.17	= 5.60		(29a)
Party wall			43.20	x 0.00	= 0.00		(32)
Total area of external elements ΣA, m ²			42.00				(31)

Fabric heat loss, W/K = Σ(A x U)	(26)...(30) + (32) =	16.98
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 (33)

Heat capacity Cm = Σ(A x k)	(28)...(30) + (32) + (32a)...(32e) =	N/A
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 (34)

Thermal mass parameter (TMP) in kJ/m ² K		100.00
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 (35)

Thermal bridges: Σ(L x Ψ) calculated using Appendix K		6.51
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 (36)

Total fabric heat loss	(33) + (36) =	23.48
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 (37)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
14.20	14.02	13.84	12.96	12.78	11.90	11.90	11.72	12.25	12.78	13.13	13.49

 (38)

Heat transfer coefficient, W/K (37)m + (38)m

37.68	37.50	37.33	36.44	36.27	35.38	35.38	35.20	35.73	36.27	36.62	36.97
Average = Σ(39)1...12/12 =											36.40

 (39)

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

0.75	0.75	0.74	0.72	0.72	0.70	0.70	0.70	0.71	0.72	0.73	0.73
Average = Σ(40)1...12/12 =											0.72

 (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
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 (40)

4. Water heating energy requirement

Assumed occupancy, N	1.70
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 (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	74.56
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 (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
82.02	79.04	76.06	73.07	70.09	67.11	67.11	70.09	73.07	76.06	79.04	82.02
Σ(44)1...12 =											894.76

 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)

121.63	106.38	109.78	95.71	91.83	79.24	73.43	84.26	85.27	99.37	108.47	117.80
Σ(45)1...12 =											1173.18

 (45)

Distribution loss 0.15 x (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
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 (46)

Storage volume (litres) including any solar or WWHRs storage within same vessel	145.00
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 (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day)	1.18
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 (48)

Temperature factor from Table 2b	0.60
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 (49)

Energy lost from water storage (kWh/day) (48) x (49)	0.71
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 (50)

Enter (50) or (54) in (55)	0.71
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 (55)

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

21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95
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 (56)

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

21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95
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 (57)

Primary circuit loss for each month from Table 3

	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m													
	143.58	126.21	131.72	116.95	113.78	100.48	95.38	106.21	106.51	121.32	129.71	139.74	(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													
	143.58	126.21	131.72	116.95	113.78	100.48	95.38	106.21	106.51	121.32	129.71	139.74	
	$\Sigma(64)1...12 =$											1431.60	(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]													
	58.00	51.23	54.06	48.81	48.09	43.34	41.97	45.58	45.34	50.60	53.06	56.73	(65)

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													
	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)
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)
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)
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)													
	77.96	76.24	72.66	67.80	64.64	60.20	56.42	61.26	62.98	68.01	73.69	76.24	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	288.27	286.55	276.82	261.30	245.84	230.74	220.81	225.65	233.52	249.21	267.20	280.41	(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	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)
Total gains - internal and solar (73)m + (83)m													
	353.35	397.40	428.50	449.24	456.35	439.72	422.29	410.30	397.76	371.73	345.15	336.10	(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)													
	0.94	0.91	0.86	0.77	0.65	0.49	0.36	0.39	0.57	0.79	0.90	0.94	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
	19.77	19.99	20.28	20.61	20.83	20.96	20.99	20.99	20.92	20.65	20.18	19.74	(87)

Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)														
	20.30	20.30	20.30	20.32	20.32	20.34	20.34	20.34	20.33	20.32	20.32	20.31	(88)	
Utilisation factor for gains for rest of dwelling n2,m														
	0.93	0.90	0.84	0.75	0.62	0.45	0.31	0.33	0.53	0.76	0.89	0.94	(89)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)														
	18.64	18.96	19.37	19.84	20.13	20.30	20.33	20.33	20.25	19.89	19.24	18.61	(90)	
Living area fraction												Living area ÷ (4) =	0.49	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2														
	19.19	19.47	19.82	20.21	20.48	20.62	20.65	20.65	20.58	20.26	19.70	19.16	(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate														
	19.19	19.47	19.82	20.21	20.48	20.62	20.65	20.65	20.58	20.26	19.70	19.16	(93)	

8. Space heating requirement														
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains, ηm														
	0.91	0.88	0.83	0.75	0.63	0.47	0.34	0.36	0.54	0.76	0.88	0.92	(94)	
Useful gains, ηmGm, W (94)m x (84)m														
	323.31	350.38	356.28	335.12	285.30	204.81	141.50	147.23	216.57	281.61	302.72	310.59	(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]														
	561.15	546.29	497.11	412.34	318.26	212.97	143.38	149.66	231.55	350.42	461.35	553.14	(97)	
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m														
	176.96	131.65	104.78	55.60	24.52	0.00	0.00	0.00	0.00	51.20	114.21	180.46		
	$\Sigma(98)1...5, 10...12 =$											839.37	(98)	
Space heating requirement kWh/m²/year												(98) ÷ (4) =	16.68	(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 (%)													100.00	(206)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Space heating fuel (main system 1), kWh/month														
	176.96	131.65	104.78	55.60	24.52	0.00	0.00	0.00	0.00	51.20	114.21	180.46		
	$\Sigma(211)1...5, 10...12 =$											839.37	(211)	

Water heating													
Efficiency of water heater													
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	(217)
Water heating fuel, kWh/month													
	143.58	126.21	131.72	116.95	113.78	100.48	95.38	106.21	106.51	121.32	129.71	139.74	
	$\Sigma(219a)1...12 =$											1431.60	(219)

Annual totals													
Space heating fuel - main system 1												839.37	
Water heating fuel												1431.60	

Electricity for pumps, fans and electric keep-hot (Table 4f)

mechanical ventilation fans - balanced, extract or positive input from outside	88.63	(230a)
Total electricity for the above, kWh/year	88.63	(231)
Electricity for lighting (Appendix L)	242.90	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) = 2602.50	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	839.37	x	13.19	x 0.01 =	110.71	(240)
Water heating	1431.60	x	13.19	x 0.01 =	188.83	(247)
Pumps and fans	88.63	x	13.19	x 0.01 =	11.69	(249)
Electricity for lighting	242.90	x	13.19	x 0.01 =	32.04	(250)
Additional standing charges					0.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		343.27	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.51	(257)
SAP value	78.90	
SAP rating (section 13)	79	(258)
SAP band	C	

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	839.37	x	0.519	=	435.63	(261)
Water heating	1431.60	x	0.519	=	743.00	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1178.63	(265)
Pumps and fans	88.63	x	0.519	=	46.00	(267)
Electricity for lighting	242.90	x	0.519	=	126.07	(268)
Total CO ₂ , kg/year			(265)...(271) =		1350.70	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		26.84	(273)
EI value					81.01	
EI rating (section 14)					81	(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	839.37	x	3.07	=	2576.86	(261)
Water heating	1431.60	x	3.07	=	4395.01	(264)
Space and water heating			(261) + (262) + (263) + (264) =		6971.87	(265)
Pumps and fans	88.63	x	3.07	=	272.10	(267)
Electricity for lighting	242.90	x	3.07	=	745.71	(268)
Primary energy kWh/year					7989.68	(272)
Dwelling primary energy rate kWh/m ² /year					158.78	(273)

DER Worksheet Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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)
<i>If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)</i>				
Air permeability value, q ₅₀ , expressed in cubic metres per hour per square metre of envelope area			4.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.20	(18)
Number of sides on which the dwelling is sheltered			3	(19)
Shelter factor		1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor		(18) x (20) =	0.16	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70

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)										
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	77.35	(23c)										
a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]												
0.31	0.31	0.30	0.28	0.28	0.26	0.26	0.26	0.27	0.28	0.29	0.30	(24a)

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
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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 x U)						(26)...(30) + (32) =	22.54	(33)					
Heat capacity Cm = Σ(A x 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 x 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)	19.95	19.70	19.45	18.21	17.96	16.72	16.72	16.47	17.22	17.96	18.46	18.96	(38)
Heat transfer coefficient, W/K (37)m + (38)m	51.04	50.79	50.54	49.30	49.05	47.81	47.81	47.56	48.31	49.05	49.55	50.05	
	Average = Σ(39)1...12/12 =											49.24	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.72	0.72	0.71	0.70	0.69	0.68	0.68	0.67	0.68	0.69	0.70	0.71	
	Average = Σ(40)1...12/12 =											0.70	(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		
	$\Sigma(44)1...12 =$											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 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													145.00	(47)
Water storage loss:														
a) If manufacturer's declared loss factor is known (kWh/day)													1.18	(48)
Temperature factor from Table 2b													0.60	(49)
Energy lost from water storage (kWh/day) (48) x (49)													0.71	(50)
Enter (50) or (54) in (55)													0.71	(55)
Water storage loss calculated for each month (55) x (41)m														
	21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - V_s] ÷ (47), else (56)														
	21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95	(57)	
Primary circuit loss for each month from Table 3														

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(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	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

165.43	145.31	151.44	134.14	130.28	114.72	108.57	121.35	121.83	139.17	149.20	160.90		(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	0.00	(63)
------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

165.43	145.31	151.44	134.14	130.28	114.72	108.57	121.35	121.83	139.17	149.20	160.90		
Σ(64)1...12 =											1642.34		(64)

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

65.27	57.58	60.62	54.53	53.58	48.07	46.36	50.61	50.44	56.54	59.54	63.76		(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												
	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)
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)
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)
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)												
	87.72	85.69	81.47	75.74	72.01	66.77	62.31	68.02	70.05	75.99	82.69	85.70 (72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m												
	362.47	360.40	347.85	327.74	307.43	287.85	275.14	280.89	291.24	311.56	334.84	352.19 (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							
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 Σ(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)
Total gains - internal and solar (73)m + (83)m													
	388.14	412.65	442.00	482.35	515.27	509.42	482.42	446.13	405.96	375.42	367.14	373.15	(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)													
0.97	0.96	0.93	0.86	0.74	0.56	0.42	0.47	0.70	0.89	0.95	0.97	(86)	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
19.58	19.74	20.04	20.46	20.77	20.94	20.98	20.98	20.86	20.47	19.98	19.57	(87)	

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

20.32	20.32	20.33	20.34	20.35	20.36	20.36	20.37	20.36	20.35	20.34	20.33	(88)
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Utilisation factor for gains for rest of dwelling n2,m

0.96	0.95	0.92	0.84	0.70	0.51	0.37	0.41	0.66	0.87	0.94	0.97	(89)
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Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)

18.39	18.62	19.05	19.65	20.08	20.30	20.35	20.35	20.20	19.68	18.98	18.38	(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

18.97	19.16	19.53	20.04	20.41	20.61	20.66	20.65	20.52	20.06	19.47	18.96	(92)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

18.97	19.16	19.53	20.04	20.41	20.61	20.66	20.65	20.52	20.06	19.47	18.96	(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	0.83	0.71	0.53	0.39	0.44	0.67	0.86	0.93	0.96	(94)

Useful gains, ηmGm, W (94)m x (84)m

369.23	386.99	400.65	401.80	364.30	271.56	189.99	196.32	272.60	322.99	342.04	356.82	(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]

748.58	724.38	658.55	549.13	427.25	287.32	193.88	202.12	310.07	464.04	612.68	738.44	(97)
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Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m

282.24	226.72	191.87	106.08	46.83	0.00	0.00	0.00	0.00	104.94	194.86	283.92	
											$\Sigma(98)1...5, 10...12 =$	1437.47 (98)
											$(98) \div (4) =$	20.33 (99)

Space heating requirement kWh/m²/year

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 (%)		100.00 (206)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month												
282.24	226.72	191.87	106.08	46.83	0.00	0.00	0.00	0.00	104.94	194.86	283.92	
											$\Sigma(211)1...5, 10...12 =$	1437.47 (211)

Water heating

Efficiency of water heater												
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	(217)
Water heating fuel, kWh/month												
165.43	145.31	151.44	134.14	130.28	114.72	108.57	121.35	121.83	139.17	149.20	160.90	
											$\Sigma(219a)1...12 =$	1642.34 (219)

Annual totals

Space heating fuel - main system 1	1437.47
Water heating fuel	1642.34

Electricity for pumps, fans and electric keep-hot (Table 4f)

mechanical ventilation fans - balanced, extract or positive input from outside	124.56	(230a)
Total electricity for the above, kWh/year	124.56	(231)
Electricity for lighting (Appendix L)	332.38	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	3536.76 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1437.47	x	13.19	x 0.01 =	189.60	(240)
Water heating	1642.34	x	13.19	x 0.01 =	216.62	(247)
Pumps and fans	124.56	x	13.19	x 0.01 =	16.43	(249)
Electricity for lighting	332.38	x	13.19	x 0.01 =	43.84	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	466.50	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.69	(257)
SAP value	76.38	
SAP rating (section 13)	76	(258)
SAP band	C	

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	1437.47	x	0.519	=	746.05	(261)
Water heating	1642.34	x	0.519	=	852.37	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1598.42	(265)
Pumps and fans	124.56	x	0.519	=	64.65	(267)
Electricity for lighting	332.38	x	0.519	=	172.51	(268)
Total CO ₂ , kg/year			(265)...(271) =		1835.58	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		25.96	(273)
EI value					78.74	
EI rating (section 14)					79	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1437.47	x	3.07	=	4413.04	(261)
Water heating	1642.34	x	3.07	=	5041.97	(264)
Space and water heating			(261) + (262) + (263) + (264) =		9455.01	(265)
Pumps and fans	124.56	x	3.07	=	382.41	(267)
Electricity for lighting	332.38	x	3.07	=	1020.42	(268)
Primary energy kWh/year					10857.84	(272)
Dwelling primary energy rate kWh/m2/year					153.53	(273)

DER Worksheet

Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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	0 x 10 =	0 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)

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

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)

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	0.93	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	k-value, kJ/m ² .K	A x k, 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 x U) (26)...(30) + (32) = (33)

Heat capacity Cm = Σ(A x k) (28)...(30) + (32) + (32a)...(32e) = (34)

Thermal mass parameter (TMP) in kJ/m²K (35)

Thermal bridges: Σ(L x Ψ) calculated using Appendix K (36)

Total fabric heat loss (33) + (36) = (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)
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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)
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Storage volume (litres) including any solar or WWHRs storage within same vessel	145.00 (47)
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Water storage loss:	1.18 (48)
a) If manufacturer's declared loss factor is known (kWh/day)	0.60 (49)

Temperature factor from Table 2b	0.71 (50)
Energy lost from water storage (kWh/day) (48) x (49)	0.71 (55)

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

0.71 (55)

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

21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95	(56)
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If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)	21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95 (57)
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Primary circuit loss for each month from Table 3

	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)	
Combi loss for each month from Table 3a, 3b or 3c														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m														
	165.43	145.31	151.44	134.14	130.28	114.72	108.57	121.35	121.83	139.17	149.20	160.90	(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														
	165.43	145.31	151.44	134.14	130.28	114.72	108.57	121.35	121.83	139.17	149.20	160.90		
												Σ(64)1...12 =	1642.34	(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]														
	65.27	57.58	60.62	54.53	53.58	48.07	46.36	50.61	50.44	56.54	59.54	63.76	(65)	

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													
	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)
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)
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)
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)													
	87.72	85.69	81.47	75.74	72.01	66.77	62.31	68.02	70.05	75.99	82.69	85.70	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	362.47	360.40	347.85	327.74	307.43	287.85	275.14	280.89	291.24	311.56	334.84	352.19	(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						
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 Σ(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)
Total gains - internal and solar (73)m + (83)m													
	388.14	412.65	442.00	482.35	515.27	509.42	482.42	446.13	405.96	375.42	367.14	373.15	(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)													
	0.97	0.96	0.94	0.89	0.80	0.66	0.53	0.58	0.78	0.91	0.96	0.97	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
	19.12	19.28	19.61	20.08	20.52	20.81	20.93	20.91	20.67	20.13	19.54	19.06	(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)	
Utilisation factor for gains for rest of dwelling n2,m														
	0.97	0.96	0.93	0.88	0.77	0.60	0.44	0.50	0.73	0.90	0.95	0.97	(89)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)														
	17.62	17.86	18.34	19.00	19.61	19.99	20.12	20.10	19.82	19.09	18.24	17.54	(90)	
Living area fraction												Living area ÷ (4) =	0.48	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2														
	18.34	18.54	18.95	19.52	20.05	20.39	20.51	20.49	20.23	19.59	18.87	18.28	(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate														
	18.34	18.54	18.95	19.52	20.05	20.39	20.51	20.49	20.23	19.59	18.87	18.28	(93)	

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	0.92	0.86	0.76	0.62	0.48	0.53	0.74	0.88	0.94	0.96	(94)	
Useful gains, ηmGm, W (94)m x (84)m														
	370.32	389.11	405.61	415.81	393.20	315.37	230.73	235.69	299.00	331.64	344.61	357.69	(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]														
	887.32	861.99	786.88	670.89	527.28	365.65	247.28	258.47	387.38	567.94	743.42	889.40	(97)	
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m														
	384.65	317.77	283.67	183.65	99.75	0.00	0.00	0.00	0.00	175.80	287.14	395.59		
												Σ(98)1...5, 10...12 =	2128.04	(98)
Space heating requirement kWh/m²/year												(98) ÷ (4)	30.09	(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 (%)													100.00	(206)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Space heating fuel (main system 1), kWh/month														
	384.65	317.77	283.67	183.65	99.75	0.00	0.00	0.00	0.00	175.80	287.14	395.59		
												Σ(211)1...5, 10...12 =	2128.04	(211)

Water heating														
Efficiency of water heater														
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	(217)	
Water heating fuel, kWh/month														
	165.43	145.31	151.44	134.14	130.28	114.72	108.57	121.35	121.83	139.17	149.20	160.90		
												Σ(219a)1...12 =	1642.34	(219)

Annual totals													
Space heating fuel - main system 1												2128.04	
Water heating fuel												1642.34	

Electricity for pumps, fans and electric keep-hot (Table 4f)

mechanical ventilation fans - balanced, extract or positive input from outside

49.35

(230a)

Total electricity for the above, kWh/year

49.35

(231)

Electricity for lighting (Appendix L)

332.38

(232)

Total delivered energy for all uses

(211)...(221) + (231) + (232)...(237b) =

4152.11

(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2128.04	x	13.19	x 0.01 =	280.69	(240)
Water heating	1642.34	x	13.19	x 0.01 =	216.62	(247)
Pumps and fans	49.35	x	13.19	x 0.01 =	6.51	(249)
Electricity for lighting	332.38	x	13.19	x 0.01 =	43.84	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	547.66	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.99	(257)
SAP value	72.27	
SAP rating (section 13)	72	(258)
SAP band	C	

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	2128.04	x	0.519	=	1104.45	(261)
Water heating	1642.34	x	0.519	=	852.37	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1956.82	(265)
Pumps and fans	49.35	x	0.519	=	25.61	(267)
Electricity for lighting	332.38	x	0.519	=	172.51	(268)
Total CO ₂ , kg/year			(265)...(271) =		2154.95	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		30.47	(273)
EI value					75.05	
EI rating (section 14)					75	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2128.04	x	3.07	=	6533.08	(261)
Water heating	1642.34	x	3.07	=	5041.97	(264)
Space and water heating			(261) + (262) + (263) + (264) =		11575.05	(265)
Pumps and fans	49.35	x	3.07	=	151.51	(267)
Electricity for lighting	332.38	x	3.07	=	1020.42	(268)
Primary energy kWh/year					12746.98	(272)
Dwelling primary energy rate kWh/m ² /year					180.25	(273)

DER Worksheet

Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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)
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)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.20	(18)
Number of sides on which the dwelling is sheltered			2	(19)
Shelter factor		1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor		(18) x (20) =	0.17	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)

Wind factor (22)m ÷ 4

1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
------	------	------	------	------	------	------	------	------	------	------	------	-------

Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m

0.22	0.21	0.21	0.19	0.18	0.16	0.16	0.16	0.17	0.18	0.19	0.20	(22b)
------	------	------	------	------	------	------	------	------	------	------	------	-------

Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system

0.50

(23a)

If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h

77.35

(23c)

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

0.33	0.33	0.32	0.30	0.30	0.27	0.27	0.27	0.28	0.30	0.30	0.31	(24a)
------	------	------	------	------	------	------	------	------	------	------	------	-------

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)
------	------	------	------	------	------	------	------	------	------	------	------	------

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 Vd,average = (25 x 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 Vd,m = factor from Table 1c x (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		
	Σ(44)1...12 =												1002.59	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/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		
	Σ(45)1...12 =												1314.55	(45)
Distribution loss 0.15 x (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													145.00	(47)
Water storage loss:														
a) If manufacturer's declared loss factor is known (kWh/day)													1.18	(48)
Temperature factor from Table 2b													0.60	(49)
Energy lost from water storage (kWh/day) (48) x (49)													0.71	(50)
Enter (50) or (54) in (55)													0.71	(55)
Water storage loss calculated for each month (55) x (41)m														
	21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)														
	21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95	(57)	

Primary circuit loss for each month from Table 3

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c													
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m													
158.24	139.02	144.95	128.48	124.85	110.03	104.23	116.37	116.78	133.30	142.79	153.94		(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	0.00	(63)
Output from water heater for each month (kWh/month) (62)m + (63)m													
158.24	139.02	144.95	128.48	124.85	110.03	104.23	116.37	116.78	133.30	142.79	153.94		
											Σ(64)1...12 =	1572.97	(64)
Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]													
62.88	55.49	58.46	52.65	51.77	46.52	44.92	48.95	48.76	54.58	57.41	61.45		(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	16.21	14.40	11.71	8.86	6.63	5.59	6.04	7.86	10.54	13.39	15.63	16.66	(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)	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)
Water heating gains (Table 5)	84.51	82.58	78.57	73.12	69.59	64.61	60.37	65.80	67.72	73.36	79.73	82.59	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	336.49	334.63	323.19	304.79	286.25	268.24	256.45	261.80	271.16	289.76	311.12	327.01	(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	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)
Total gains - internal and solar (73)m + (83)m													
	446.64	522.26	579.91	622.88	642.54	621.95	597.46	574.32	549.14	497.13	443.06	421.27	(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)													
0.95	0.93	0.89	0.82	0.72	0.58	0.44	0.47	0.66	0.84	0.93	0.96		(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													

	18.94	19.24	19.65	20.15	20.55	20.83	20.94	20.93	20.74	20.21	19.50	18.90	(87)		
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)		
Utilisation factor for gains for rest of dwelling n2,m															
	0.94	0.92	0.87	0.79	0.68	0.51	0.36	0.39	0.60	0.81	0.92	0.95	(89)		
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)															
	17.28	17.71	18.30	19.00	19.55	19.91	20.03	20.02	19.80	19.11	18.10	17.22	(90)		
Living area fraction										Living area ÷ (4) =				0.42	(91)
Mean internal temperature for the whole dwelling fLa x T1 +(1 - fLa) x T2															
	17.98	18.35	18.87	19.48	19.97	20.30	20.41	20.40	20.20	19.57	18.69	17.93	(92)		
Apply adjustment to the mean internal temperature from Table 4e where appropriate															
	17.98	18.35	18.87	19.48	19.97	20.30	20.41	20.40	20.20	19.57	18.69	17.93	(93)		

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, η_m													
	0.92	0.89	0.85	0.78	0.67	0.53	0.39	0.42	0.61	0.80	0.90	0.93	(94)
Useful gains, $\eta_m G_m$, W (94)m x (84)m													
	413.10	466.69	492.27	484.00	432.65	329.34	234.56	242.69	335.15	395.82	396.59	393.20	(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, L_m , W [(39)m x ((93)m - (96)m]													
	930.30	911.53	834.96	701.65	546.41	369.54	247.07	258.37	398.33	592.59	771.03	920.05	(97)
Space heating requirement, kWh/month 0.024 x ((97)m - (95)m) x (41)m													
	384.79	298.94	254.97	156.71	84.63	0.00	0.00	0.00	0.00	146.39	269.60	391.97	
	$\Sigma(98)1...5, 10...12 =$												1988.00 (98)
Space heating requirement kWh/m ² /year													
	$(98) \div (4) =$												31.32 (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 (%)

100.00

(206)

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

Space heating fuel (main system 1), kWh/month

384.79

298.94

254.97

156.71

84.63

0.00

0.00

0.00

0.00

146.39

269.60

391.97

$\sum\{211\}1\dots5, 10\dots12 =$

1988.00

(211)

Water heating

Efficiency of water heater

100.00

100.00

100.00

100.00

100.00

100.00

100.00

100.00

100.00

100.00

100.00

100.00

(217)

Water heating fuel, kWh/month

158.24

139.02

144.95

128.48

124.85

110.03

104.23

116.37

116.78

133.30

142.79

153.94

$\sum\{219a\}1\dots12 =$

1572.97

(219)

Annual totals

Space heating fuel - main system 1

1988.00

Water heating fuel	1572.97														
Electricity for pumps, fans and electric keep-hot (Table 4f)															
mechanical ventilation fans - balanced, extract or positive input from outside	133.09												(230a)		
Total electricity for the above, kWh/year													133.09	(231)	
Electricity for lighting (Appendix L)													286.23	(232)	
Total delivered energy for all uses													(211)...(221) + (231) + (232)...(237b) =	3980.29	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1988.00	x	13.19	x 0.01 =	262.22	(240)
Water heating	1572.97	x	13.19	x 0.01 =	207.47	(247)
Pumps and fans	133.09	x	13.19	x 0.01 =	17.55	(249)
Electricity for lighting	286.23	x	13.19	x 0.01 =	37.75	(250)
Additional standing charges					0.00	(251)
Total energy cost					(240)...(242) + (245)...(254) =	(255)
	525.00					

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	2.03	(257)
SAP value	71.64	
SAP rating (section 13)	72	(258)
SAP band	C	

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	1988.00	x	0.519	=	1031.77	(261)
Water heating	1572.97	x	0.519	=	816.37	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1848.14	(265)
Pumps and fans	133.09	x	0.519	=	69.07	(267)
Electricity for lighting	286.23	x	0.519	=	148.55	(268)
Total CO ₂ , kg/year					(265)...(271) =	(272)
	2065.77					
Dwelling CO ₂ emission rate					(272) ÷ (4) =	(273)
	32.55					
EI value					74.48	
EI rating (section 14)					74	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1988.00	x	3.07	=	6103.16	(261)
Water heating	1572.97	x	3.07	=	4829.02	(264)
Space and water heating			(261) + (262) + (263) + (264) =		10932.18	(265)
Pumps and fans	133.09	x	3.07	=	408.58	(267)
Electricity for lighting	286.23	x	3.07	=	878.72	(268)
Primary energy kWh/year					12219.49	(272)
Dwelling primary energy rate kWh/m2/year					192.52	(273)

DER Worksheet

Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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	0 x 10 =	0 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)

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

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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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	<table><tr><td>1.28</td><td>1.25</td><td>1.23</td><td>1.10</td><td>1.08</td><td>0.95</td><td>0.95</td><td>0.93</td><td>1.00</td><td>1.08</td><td>1.13</td><td>1.18</td></tr></table>											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)
1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18													

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)

Calculate effective air change rate for the applicable case:	
If mechanical ventilation: air change rate through system	0.50 (23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	77.35 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]												(24a)
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)

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)

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 0.10	= 6.32		(28a)
External wall			82.52	x 0.17	= 14.03		(29a)
Total area of external elements ΣA, m ²			159.47				(31)

Fabric heat loss, W/K = Σ(A x U)	(26)...(30) + (32) = 37.97 (33)
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Heat capacity Cm = Σ(A x κ)	(28)...(30) + (32) + (32a)...(32e) = N/A (34)
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Thermal mass parameter (TMP) in kJ/m ² K	100.00 (35)
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Thermal bridges: Σ(L x Ψ) calculated using Appendix K	13.02 (36)
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Total fabric heat loss	(33) + (36) = 50.99 (37)
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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 = $\sum(39)1...12/12 =$										68.14	(39)

Heat loss parameter (HLP), W/m²K (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 = $\sum(40)1...12/12 =$											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 Vd,average = (25 x N) + 36	83.36 (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
91.69	88.36	85.02	81.69	78.35	75.02	75.02	78.35	81.69	85.02	88.36	91.69

 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/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	
										Σ(45)1...12 =	1311.50	(45)

Distribution loss 0.15 x (45)m												(46)
20.40	17.84	18.41	16.05	15.40	13.29	12.31	14.13	14.30	16.66	18.19	19.75	

Storage volume (litres) including any solar or WWHRS storage within same vessel	145.00 (47)
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Water storage loss:	
a) If manufacturer's declared loss factor is known (kWh/day)	1.18 (48)
Temperature factor from Table 2b	0.60 (49)
Energy lost from water storage (kWh/day) (48) x (49)	0.71 (50)
Enter (50) or (54) in (55)	0.71 (55)

Water storage loss calculated for each month (55) x (41)m												
21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95	(56)

If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)												
21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95	(57)

Primary circuit loss for each month from Table 3

	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c													
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m													
	157.92	138.75	144.67	128.23	124.61	109.83	104.04	116.15	116.56	133.04	142.50	153.63	(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													
	157.92	138.75	144.67	128.23	124.61	109.83	104.04	116.15	116.56	133.04	142.50	153.63	
	$\Sigma(64)1...12 =$											1569.92	(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]													
	62.77	55.40	58.36	52.57	51.69	46.45	44.85	48.88	48.69	54.50	57.31	61.34	(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													
	16.15	14.35	11.67	8.83	6.60	5.57	6.02	7.83	10.51	13.34	15.57	16.60	(67)
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)
Water heating gains (Table 5)													
	84.37	82.44	78.44	73.01	69.48	64.51	60.29	65.70	67.62	73.25	79.60	82.45	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	335.43	333.58	322.17	303.83	285.36	267.42	255.66	261.00	270.34	288.86	310.16	325.98	(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							
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)
Total gains - internal and solar (73)m + (83)m													
	368.65	401.19	443.98	503.88	554.27	554.10	523.85	474.81	418.77	371.49	351.95	353.11	(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)													
	0.97	0.96	0.93	0.88	0.78	0.63	0.50	0.56	0.77	0.91	0.96	0.97	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													

	18.67	18.88	19.30	19.89	20.42	20.78	20.91	20.88	20.59	19.93	19.22	18.65	(87)
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	0.86	0.74	0.57	0.41	0.47	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)													
	16.87	17.18	17.78	18.63	19.36	19.83	19.98	19.95	19.61	18.70	17.68	16.84	(90)
Living area fraction												Living area ÷ (4) =	0.31 (91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
	17.43	17.70	18.24	19.02	19.68	20.12	20.26	20.24	19.91	19.08	18.15	17.40	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
	17.43	17.70	18.24	19.02	19.68	20.12	20.26	20.24	19.91	19.08	18.15	17.40	(93)

8. Space heating requirement													
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
	0.95	0.93	0.90	0.83	0.72	0.57	0.43	0.49	0.71	0.87	0.93	0.95	(94)
Useful gains, ηmGm, W (94)m x (84)m													
	348.68	373.76	399.73	419.89	400.91	317.08	227.54	231.65	295.79	321.83	326.80	335.75	(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]													
	917.55	891.62	815.30	690.16	542.40	368.22	244.52	255.23	390.31	576.25	756.54	909.67	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
	423.24	348.00	309.19	194.59	105.27	0.00	0.00	0.00	0.00	189.29	309.41	426.99	
	$\Sigma(98)1...5, 10...12 =$											2305.99	(98)
Space heating requirement kWh/m²/year												(98) ÷ (4)	36.50 (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 (%)												100.00	(206)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month													
	423.24	348.00	309.19	194.59	105.27	0.00	0.00	0.00	0.00	189.29	309.41	426.99	
	$\Sigma(211)1...5, 10...12 =$											2305.99	(211)

Water heating													
Efficiency of water heater													
	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	(217)	
Water heating fuel, kWh/month													
	157.92	138.75	144.67	128.23	124.61	109.83	104.04	116.15	116.56	133.04	142.50	153.63	
	$\Sigma(219a)1...12 =$											1569.92	(219)
Annual totals													
Space heating fuel - main system 1												2305.99	

Water heating fuel				1569.92	
Electricity for pumps, fans and electric keep-hot (Table 4f)					
mechanical ventilation fans - balanced, extract or positive input from outside			132.46		(230a)
Total electricity for the above, kWh/year				132.46	(231)
Electricity for lighting (Appendix L)				285.24	(232)
Total delivered energy for all uses	(211)...	(221) + (231) + (232)...	(237b) =	4293.61	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2305.99	x	13.19	x 0.01 =	304.16	(240)
Water heating	1569.92	x	13.19	x 0.01 =	207.07	(247)
Pumps and fans	132.46	x	13.19	x 0.01 =	17.47	(249)
Electricity for lighting	285.24	x	13.19	x 0.01 =	37.62	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...	(242) + (245)...	(254) = 566.33 (255)

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

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)		2.20	(257)
SAP value		69.33	
SAP rating (section 13)		69	(258)
SAP band		C	

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	2305.99	x	0.519	=	1196.81	(261)
Water heating	1569.92	x	0.519	=	814.79	(264)
Space and water heating				(261) + (262) + (263) + (264) =	2011.60	(265)
Pumps and fans	132.46	x	0.519	=	68.75	(267)
Electricity for lighting	285.24	x	0.519	=	148.04	(268)
Total CO ₂ , kg/year				(265)...	(271) = 2228.38	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	35.28	(273)
EI value					72.39	
EI rating (section 14)					72	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2305.99	x	3.07	=	7079.38	(261)
Water heating	1569.92	x	3.07	=	4819.67	(264)
Space and water heating				(261) + (262) + (263) + (264) =	11899.05	(265)
Pumps and fans	132.46	x	3.07	=	406.65	(267)
Electricity for lighting	285.24	x	3.07	=	875.69	(268)
Primary energy kWh/year					13181.39	(272)
Dwelling primary energy rate kWh/m ² /year					208.67	(273)

DER Worksheet Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
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	$\div (5) =$	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)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.20	(18)
Number of sides on which the dwelling is sheltered	3	(19)
Shelter factor	1 - [0.075 x (19)] = 0.78	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.16	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)

Wind factor (22)m ÷ 4

	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
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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)

If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h 77.35 (23c)

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

	0.31	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 Vd,average = (25 x 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 Vd,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			
													Σ(44)1...12 =	1022.46	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/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			
													Σ(45)1...12 =	1340.61	(45)
Distribution loss 0.15 x (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													145.00	(47)	
Water storage loss:															
a) If manufacturer's declared loss factor is known (kWh/day)													1.18	(48)	
Temperature factor from Table 2b													0.60	(49)	
Energy lost from water storage (kWh/day) (48) x (49)													0.71	(50)	
Enter (50) or (54) in (55)													0.71	(55)	
Water storage loss calculated for each month (55) x (41)m															
	21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95	(56)		
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)															
	21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95	(57)		

Primary circuit loss for each month from Table 3

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c													
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m													
160.94	141.39	147.39	130.60	126.89	111.79	105.86	118.24	118.68	135.50	145.20	156.56		(62)
Solar DHW input calculated using Appendix G or Appendix H													
0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
Output from water heater for each month (kWh/month) (62)m + (63)m													
160.94	141.39	147.39	130.60	126.89	111.79	105.86	118.24	118.68	135.50	145.20	156.56		
											Σ(64)1...12 =	1599.03	(64)
Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]													
63.77	56.28	59.27	53.36	52.45	47.10	45.46	49.57	49.39	55.32	58.21	62.32		(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	(66)
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)
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)
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)	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)	-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)	85.72	83.75	79.66	74.11	70.50	65.42	61.10	66.63	68.60	74.35	80.84	83.76	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	346.89	344.86	332.88	313.71	294.41	275.77	263.66	269.25	279.11	298.47	320.66	337.13	(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						
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 Σ(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)
Total gains - internal and solar (73)m + (83)m	421.79	472.45	507.45	530.01	536.69	516.30	495.55	481.76	468.13	439.48	410.37	401.23 (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)													
0.96	0.94	0.91	0.86	0.77	0.63	0.49	0.52	0.71	0.87	0.94	0.96		(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													

19.11	19.35	19.70	20.15	20.54	20.83	20.94	20.93	20.74	20.25	19.61	19.08	(87)	
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)	
Utilisation factor for gains for rest of dwelling n2,m													
0.95	0.93	0.90	0.84	0.74	0.57	0.41	0.65	0.85	0.93	0.96		(89)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
17.58	17.92	18.43	19.08	19.61	19.99	20.12	20.11	19.89	19.22	18.32	17.54	(90)	
Living area fraction													
Living area ÷ (4) =												0.43	(91)
Mean internal temperature for the whole dwelling fLa x T1 + (1 - fLa) x T2													
18.23	18.53	18.97	19.54	20.01	20.35	20.47	20.46	20.25	19.66	18.87	18.19	(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
18.23	18.53	18.97	19.54	20.01	20.35	20.47	20.46	20.25	19.66	18.87	18.19	(93)	

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Utilisation factor for gains, ηm														
0.94	0.91	0.88	0.82	0.73	0.59	0.44	0.47	0.66	0.83	0.91	0.94	(94)		
Useful gains, ηmGm, W (94)m x (84)m														
395.03	431.99	446.85	435.86	391.99	303.87	219.85	227.34	309.45	364.77	374.24	378.49	(95)		
Monthly average external temperature from Table U1														
4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20	(96)		
Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]														
881.39	858.95	783.17	655.57	510.29	346.35	233.00	243.50	373.54	556.36	728.32	872.24	(97)		
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m														
361.85	286.92	250.22	158.19	88.02	0.00	0.00	0.00	0.00	142.54	254.94	367.35			
Σ(98)1...5, 10...12 =												1910.02	(98)	
Space heating requirement kWh/m²/year												(98) ÷ (4)	28.90	(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 (%)												100.00	(206)	
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Space heating fuel (main system 1), kWh/month														
361.85	286.92	250.22	158.19	88.02	0.00	0.00	0.00	0.00	142.54	254.94	367.35			
Σ(211)1...5, 10...12 =												1910.02	(211)	
Water heating														
Efficiency of water heater														
100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	(217)		
Water heating fuel, kWh/month														
160.94	141.39	147.39	130.60	126.89	111.79	105.86	118.24	118.68	135.50	145.20	156.56			
Σ(219a)1...12 =												1599.03	(219)	
Annual totals														
Space heating fuel - main system 1												1910.02		

Water heating fuel	1599.03	
Electricity for pumps, fans and electric keep-hot (Table 4f)		
mechanical ventilation fans - balanced, extract or positive input from outside	138.58	(230a)
Total electricity for the above, kWh/year	138.58	(231)
Electricity for lighting (Appendix L)	317.01	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	3964.65 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1910.02	x	13.19	x 0.01 =	251.93	(240)
Water heating	1599.03	x	13.19	x 0.01 =	210.91	(247)
Pumps and fans	138.58	x	13.19	x 0.01 =	18.28	(249)
Electricity for lighting	317.01	x	13.19	x 0.01 =	41.81	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	522.94	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.98	(257)
SAP value	72.42	
SAP rating (section 13)	72	(258)
SAP band	C	

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	1910.02	x	0.519	=	991.30	(261)
Water heating	1599.03	x	0.519	=	829.90	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1821.20	(265)
Pumps and fans	138.58	x	0.519	=	71.92	(267)
Electricity for lighting	317.01	x	0.519	=	164.53	(268)
Total CO ₂ , kg/year			(265)...(271) =		2057.65	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		31.13	(273)
EI value					75.18	
EI rating (section 14)					75	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1910.02	x	3.07	=	5863.77	(261)
Water heating	1599.03	x	3.07	=	4909.03	(264)
Space and water heating			(261) + (262) + (263) + (264) =		10772.80	(265)
Pumps and fans	138.58	x	3.07	=	425.45	(267)
Electricity for lighting	317.01	x	3.07	=	973.23	(268)
Primary energy kWh/year					12171.48	(272)
Dwelling primary energy rate kWh/m2/year					184.17	(273)

DER Worksheet

Design - Draft



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

Assessor name	Mr Jonathan Peck	Assessor number	10160
Client		Last modified	17/12/2019
Address	18 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	0 x 10 =	0 (7a)
Number of passive vents	0 x 10 =	0 (7b)
Number of flueless gas fires	0 x 40 =	0 (7c)

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

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	4.00 (17)
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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
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	0.93	1.00	1.08	1.13	1.18
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(22a)

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	0.17	0.18	0.19	0.20
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(22b)

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	0.31
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(24a)

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	0.31
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(25)

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	k-value, kJ/m ² .K	A x k, 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 x U)	(26)...(30) + (32) =	26.56	(33)
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Heat capacity Cm = Σ(A x k)	(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)
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Thermal mass parameter (TMP) in kJ/m ² K		100.00	(35)
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Thermal bridges: Σ(L x Ψ) calculated using Appendix K		11.79	(36)
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Total fabric heat loss	(33) + (36) =	38.35	(37)
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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 = $\sum(39)1...12/12 =$												52.10	(39)

Heat loss parameter (HLP), W/m²K (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 = $\sum(40)1...12/12 =$												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
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(40)

4. Water heating energy requirement

Assumed occupancy, N	1.71	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	74.80	(43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
82.28	79.29	76.30	73.31	70.31	67.32	67.32	70.31	73.31	76.30	79.29	82.28

Σ(44)1...12 = (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 x (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	145.00	(47)
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Water storage loss:		
a) If manufacturer's declared loss factor is known (kWh/day)	1.18	(48)
Temperature factor from Table 2b	0.60	(49)
Energy lost from water storage (kWh/day) (48) x (49)	0.71	(50)
Enter (50) or (54) in (55)	0.71	(55)

Water storage loss calculated for each month (55) x (41)m	21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95
---	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------

(56)

If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)	21.95	19.82	21.95	21.24	21.95	21.24	21.95	21.95	21.24	21.95	21.24	21.95
---	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------	------------------------------------

(57)

Primary circuit loss for each month from Table 3

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

 (59)

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

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

 (61)

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

143.97	126.54	132.07	117.25	114.07	100.74	95.61	106.48	106.78	121.64	130.06	140.12
--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------

 (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

143.97	126.54	132.07	117.25	114.07	100.74	95.61	106.48	106.78	121.64	130.06	140.12
											$\Sigma(64)1...12 =$
											1435.34

 (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]

58.13	51.34	54.18	48.92	48.19	43.42	42.05	45.67	45.43	50.71	53.17	56.85
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 (65)

5. Internal gains

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

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
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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
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (69)

Pump and fan gains (Table 5a)

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

 (70)

Losses e.g. evaporation (Table 5)

-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38	-68.38
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (71)

Water heating gains (Table 5)

78.13	76.40	72.82	67.94	64.77	60.31	56.52	61.38	63.10	68.15	73.85	76.41
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 (72)

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

289.00	287.34	277.65	262.15	246.68	231.54	221.55	226.34	234.17	249.84	267.84	281.08
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (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	x 6.72	x 36.79	x 0.9 x 0.45	x 0.80	= 61.69
NorthWest	0.77	x 3.84	x 11.28	x 0.9 x 0.45	x 0.80	= 10.81

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

72.49	127.07	183.41	243.23	287.03	291.37	278.24	244.59	203.97	143.02	87.49	61.62
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 (83)

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

361.50	414.41	461.06	505.38	533.71	522.91	499.79	470.93	438.14	392.85	355.32	342.70
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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
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	0.93	0.89	0.81	0.70	0.55	0.42	0.46	0.66	0.84	0.93	0.95
------	------	------	------	------	------	------	------	------	------	------	------

 (86)

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

18.99	19.27	19.68	20.19	20.60	20.86	20.95	20.94	20.75	20.23	19.53	18.95
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (87)

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
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 (88)

Utilisation factor for gains for rest of dwelling n2,m

0.94	0.92	0.87	0.79	0.66	0.49	0.34	0.38	0.60	0.81	0.91	0.95
------	------	------	------	------	------	------	------	------	------	------	------

 (89)

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

17.36	17.75	18.34	19.06	19.61	19.95	20.04	20.04	19.83	19.13	18.15	17.31
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (90)

Living area fraction

Living area ÷ (4) =

0.62

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

18.37	18.69	19.17	19.76	20.22	20.51	20.61	20.59	20.40	19.81	19.01	18.33
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 (92)

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

18.37	18.69	19.17	19.76	20.22	20.51	20.61	20.59	20.40	19.81	19.01	18.33
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation factor for gains, η_m	0.93	0.90	0.85	0.78	0.67	0.52	0.39	0.43	0.62	0.81	0.90	0.93

 (94)

Useful gains, $\eta_m G_m$, W (94)m x (84)m

334.88	372.40	393.91	392.81	354.98	271.05	194.44	200.23	271.31	316.29	319.26	320.12
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (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
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 (96)

Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

753.19	735.50	673.21	566.48	442.78	301.41	204.28	213.03	323.71	478.63	623.53	745.12
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 (97)

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

311.22	244.01	207.79	125.05	65.32	0.00	0.00	0.00	0.00	120.78	219.07	316.20
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$\Sigma(98)1...5, 10...12 =$

1609.44

Space heating requirement kWh/m²/year

(98) ÷ (4)

31.77

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

Space heating

Fraction of space heat from secondary/supplementary system (table 11)		0.00
Fraction of space heat from main system(s)	1 - (201) =	1.00
Fraction of space heat from main system 2		0.00
Fraction of total space heat from main system 1	(202) x [1 - (203)] =	1.00
Fraction of total space heat from main system 2	(202) x (203) =	0.00
Efficiency of main system 1 (%)		100.00

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	311.22	244.01	207.79	125.05	65.32	0.00	0.00	0.00	0.00	120.78	219.07	316.20
											$\Sigma(211)1...5, 10...12 =$	1609.44

 (211)

Water heating

Efficiency of water heater	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
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 (217)

Water heating fuel, kWh/month

143.97	126.54	132.07	117.25	114.07	100.74	95.61	106.48	106.78	121.64	130.06	140.12
--------	--------	--------	--------	--------	--------	-------	--------	--------	--------	--------	--------

$\Sigma(219a)1...12 =$

1435.34

Annual totals

Space heating fuel - main system 1		1609.44	
Water heating fuel		1435.34	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	89.23		(230a)
Total electricity for the above, kWh/year		89.23	(231)
Electricity for lighting (Appendix L)		234.51	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	3368.53	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1609.44	x	13.19	x 0.01 =	212.29	(240)
Water heating	1435.34	x	13.19	x 0.01 =	189.32	(247)
Pumps and fans	89.23	x	13.19	x 0.01 =	11.77	(249)
Electricity for lighting	234.51	x	13.19	x 0.01 =	30.93	(250)
Additional standing charges					0.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		444.31	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.95	(257)
SAP value	72.79	
SAP rating (section 13)	73	(258)
SAP band	C	

12a. CO₂ emissions - individual heating systems including micro-CHP

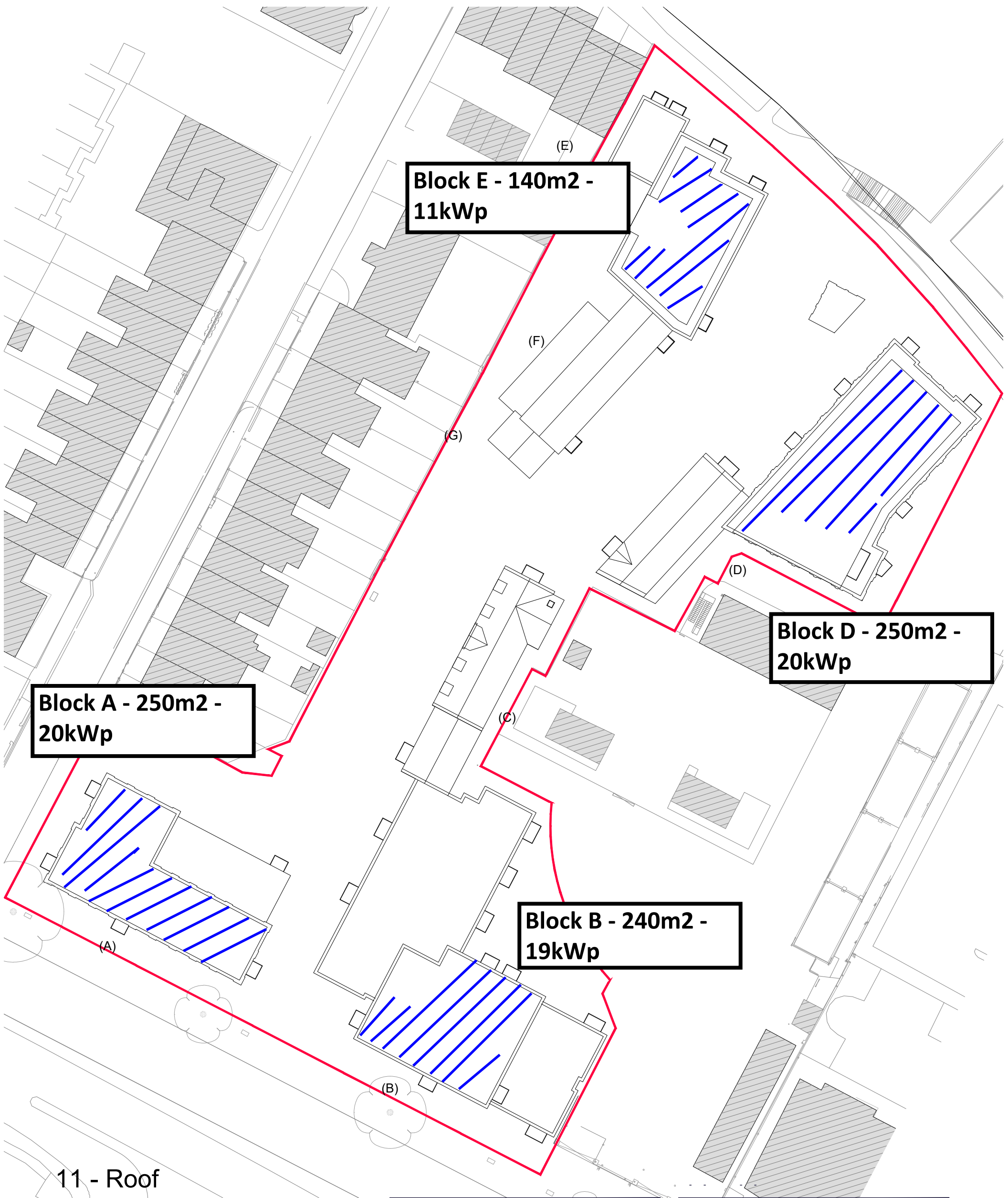
	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO ₂ /year	
Space heating - main system 1	1609.44	x	0.519	=	835.30	(261)
Water heating	1435.34	x	0.519	=	744.94	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1580.24	(265)
Pumps and fans	89.23	x	0.519	=	46.31	(267)
Electricity for lighting	234.51	x	0.519	=	121.71	(268)
Total CO ₂ , kg/year			(265)...(271) =		1748.26	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		34.51	(273)
EI value					75.51	
EI rating (section 14)					76	(274)
EI band					C	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	1609.44	x	3.07	=	4940.99	(261)
Water heating	1435.34	x	3.07	=	4406.50	(264)
Space and water heating			(261) + (262) + (263) + (264) =		9347.49	(265)
Pumps and fans	89.23	x	3.07	=	273.94	(267)
Electricity for lighting	234.51	x	3.07	=	719.94	(268)
Primary energy kWh/year					10341.37	(272)
Dwelling primary energy rate kWh/m ² /year					204.13	(273)

Appendix D

PV Panels – Indicative Roof Plan



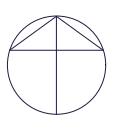
**Block A - 250m2 -
20kWp**

**Block E - 140m2 -
11kWp**

**Block D - 250m2 -
20kWp**

**Block B - 240m2 -
19kWp**

11 - Roof



project Vastern Road Reading			revision	date	prepared	description		
drawing Proposed Floor Plans 11 - Roof							Berkeley Designed for life	
date January 2020	scale @ a3 1:500	drawn EE						
drawing number 448.SK.111		revision /						
			Berkeley House Farnham Lane Farnham Royal SL2 3RQ				T: 01753 784400 F: 01753 646855 www.berkeleygroup.co.uk	