



HODKINSON



Energy Statement

Elstree Land Ltd

45 Caversham Road

Final

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Executive Summary

The purpose of this document is to outline the proposed energy strategy for the proposed development at 45 Caversham Road, by Elstree Land Ltd. The energy strategy has been formulated following the energy hierarchy, reducing energy demand through energy efficiency measures, before considering the inclusion of a decentralised energy supply and renewable energy technologies.

The proposed development is for 40 new-build residential dwellings.

In line with Reading Borough Council's Sustainable Design and Construction SPD, the predicted CO₂ emissions of the proposed development have been estimated using both SAP 2012 and updated SAP 10 carbon emission factors. The figures presented throughout the main report have been calculated using SAP 10 carbon emission factors, as these are considered a more accurate representation of carbon dioxide emissions. However, performance using SAP 2012 carbon emission factors are also presented in the Appendix.

A range of advance **Energy Efficiency** measures are proposed. Along with an electric boiler heating strategy, this allows the development to achieve a **22%** CO₂ reduction over a Part L 2013 baseline.

In line with Reading Borough Council's Local Plan, the feasibility of a decentralised energy production has been considered. There are no known heat networks in close proximity of the development, and due to the small scale of the development, it is not considered feasible to install a site-wide network. It is proposed that the heating and hot water is supplied by electric boilers.

A range of **Renewable Energy Technologies** has been considered. It is proposed to maximise the roof space available to provide 30 kWp of Solar PV to the proposed development. This provides a further **13%** reduction in Regulated CO₂ emissions over the first stage of the Energy Hierarchy.

Table *i* below summarises the anticipated CO₂ emissions of the proposed development following the **Energy Efficiency** and **Renewable Energy Technology** measures proposed. The combination of these measures results in an on-site **35%** CO₂ reduction over a Part L 2013 baseline, using SAP 10 carbon emission factors.

In line with Reading Borough Council's Local Plan, any residual CO₂ emissions will be offset so the development achieves zero carbon homes standard. The offsetting price is calculated as £60 per tonne of CO₂ over a period of 30 years. The estimated remaining Regulated CO₂ emissions are calculated to be **28 Tonnes CO₂ per annum**, resulting in a carbon offset payment of **£50,400**.

Table i: Total Site-Wide Regulated Carbon Dioxide Emissions

Stage	Carbon Dioxide Emissions (Tonnes CO ₂ per Annum)	% Reduction
Part L 2013 Baseline	42	-
After <i>Energy Efficiency</i> Measures	33	22%
After <i>Renewable Technology</i> Measures	28	13%
Cumulative Saving	15	35%

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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, to present the energy strategy for the proposed residential development at 45 Caversham Road, in Reading, by Elstree Land Ltd.
- 1.2** The formulation of the energy strategy for the proposed development takes into account several important concerns and priorities. These include:
- > Compliance with national and local energy policy requirements;
 - > To achieve the maximum feasible reduction in carbon dioxide (CO₂) emissions through the application of the energy hierarchy, with an affordable, deliverable and technically appropriate strategy;
 - > Provision of high quality low energy homes that are adapted to future changes in climate.
- 1.3** This statement first establishes a baseline assessment of the energy demands and associated CO₂ emissions for the proposed development. The report will then follow the energy hierarchy to enable the maximum feasible reductions in Regulated CO₂ emissions over the baseline. The energy hierarchy aims to first reduce energy demand through energy efficient measures, before considering decentralised energy supply and renewable energy technologies.

2. DEVELOPMENT OVERVIEW

Site Location

- 2.1** The proposed development site at 45 Caversham Road in the Borough of Reading is located at 45 Caversham Road, Reading RG1 7BT as shown in Figure 1 below.

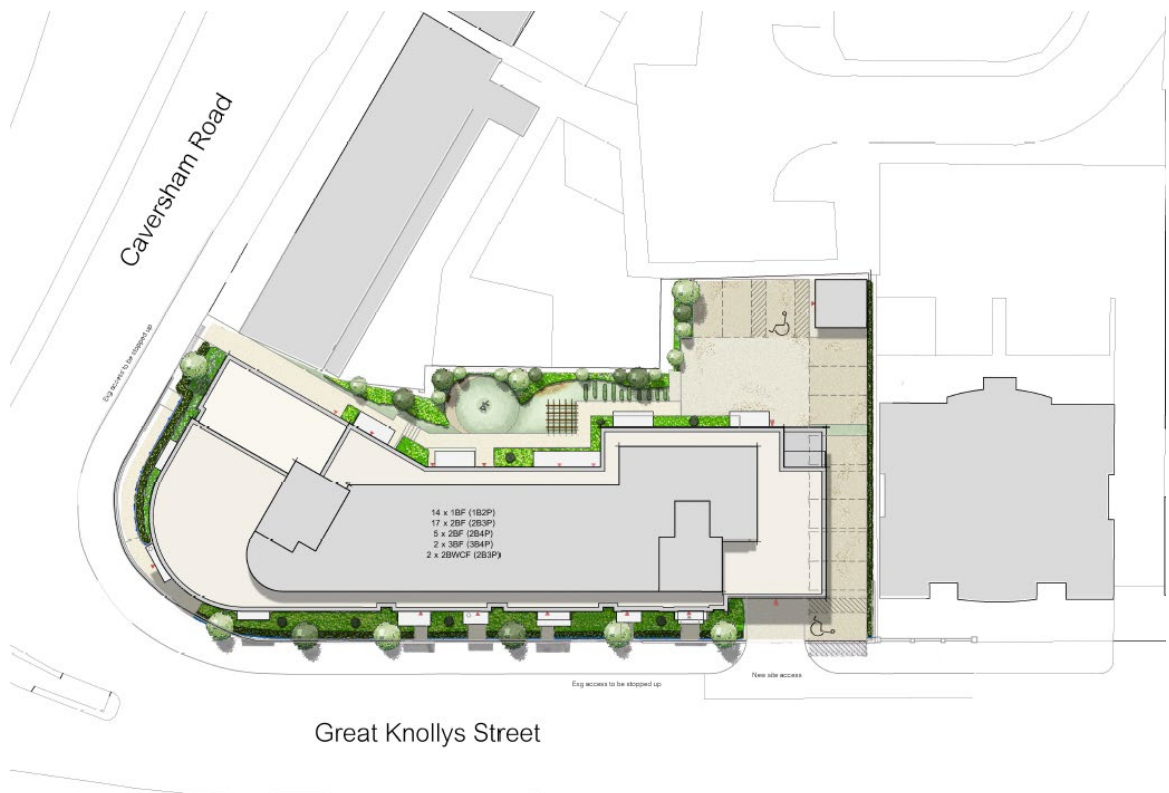


Figure 1: Site Location – Map data © 2020 Google

- 2.2** The site is currently occupied by Avis Car Rental and is located in a mixed-use area, bounded to the north by Great Knollys Street and to the east by Caversham Road. There are residential dwellings to the west and south of the site. Further to the east are offices and residential premises and to the north are residential and commercial premises including Thimbleby & Shotland Auction Centre and Farmers Market.

Proposed Development

2.3 The proposed development is described as follows:

“Demolition of existing buildings and construction of 40 flats with associated landscaping and parking.”

2.4 Figure 2 below illustrates the proposed site layout.

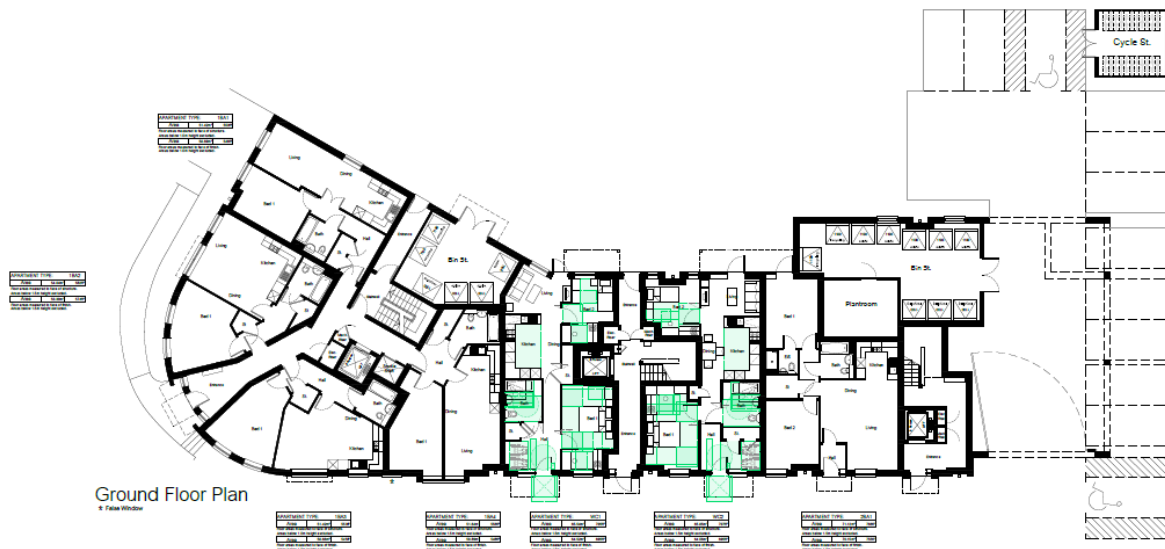


Figure 2: Proposed Site Layout – Ground Floor (DHA Architecture Ltd, 2020)

3. RELEVANT PLANNING POLICY

- 3.1 The following planning policies and requirements have informed the sustainable design of the proposed development.

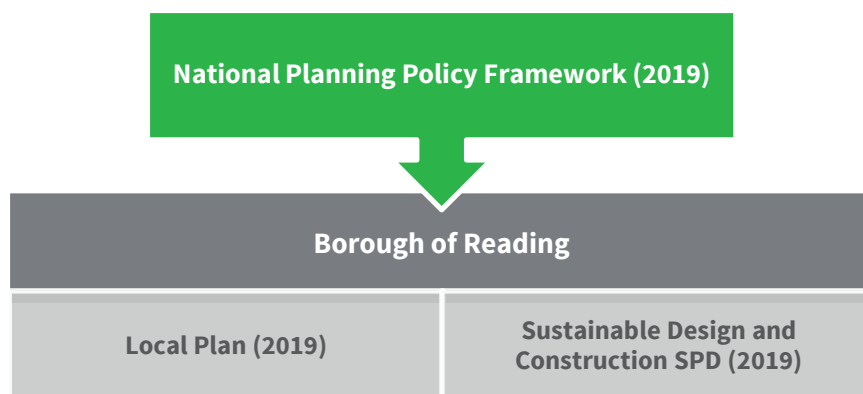


Figure 3: Relevant Planning Policy Documents

National Policy: NPPF

- 3.2 The revised National Planning Policy Framework (NPPF) was published on the 19th June 2019 and sets out the Government's planning policies for England.
- 3.3 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**.
- 3.4 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 type 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.

Local Policy: Borough of Reading

Local Plan

- 3.5 The Borough of Reading's Local Plan was adopted in 2019. The following policies are considered relevant to this Statement:
- 3.6 **Policy CC2: Sustainable design and construction** requires development to use energy, water, minerals, and other natural resources appropriately, efficiently and with care and account for the effects of climate change. Development should include measures for recycling greywater and rainwater harvesting where this is energy- and cost-effective.
- 3.7 **Policy CC3: Adaptation to climate change** requires development to incorporate measures to adapt to climate change. This includes the inclusion of measures such as solar shading, green roofs/walls, tree planting to provide shade in amenity areas. Development should also be designed to minimise the impact of surface water runoff.
- 3.8 **Policy CC4: Decentralised energy** states that any development of 20 dwellings or more should consider the inclusion of decentralised energy provision, unless it can be shown that it is not feasible. Development should also connect to any existing decentralised energy supply if there is one within proximity to the proposed development.
- 3.9 **Policy H5: Standards for new housing** states that new development should comply with the nationally described space standard and be built to the higher water efficiency standard under Regulation 36(3) of the Building regulations. In addition, residential development should be designed to achieve zero carbon homes.

Sustainable Design and Construction Supplementary Planning Document (SPD)

- 3.10 This SPD explains planning requirements with regard to energy, climate change, water management and waste reduction. It is intended to supplement the policies of the local plan. It was adopted in 2019.
- 3.11 In achieving Zero Carbon Homes for major residential developments (over 10 dwellings), the preference is to achieve true carbon neutral development on-site. If this is not achievable, a minimum of 35% improvement in regulated emissions over the Target Emissions Rate in the 2013 Building Regulations, plus a Section 106 contribution towards carbon offsetting must be made.

The energy strategy should be developed following the energy hierarchy, reducing energy demand from fabric energy efficiency measures, before considering the inclusion of a decentralised energy supply and renewable energy technologies.

- 3.12 Ventilation:** The use of natural ventilation should be maximised. However, mechanical ventilation may be required to supplement natural ventilation, but this should be energy efficient.
- 3.13 Energy efficient appliances:** The most energy efficient domestic appliances should be used as far as possible, particularly with regard to energy and water efficient white goods.

Policy Target Summary

- 3.14** The development should aim to achieve *Zero Carbon Homes* Standard. A minimum 35% CO₂ reduction should be achieved on-site, with any residual carbon offset through a payment to Reading Borough Council, to be put towards carbon savings elsewhere in the borough.
- 3.15** The feasibility of a decentralised energy system should be considered for the development.

4. METHODOLOGY AND BASELINE

- 4.1** The estimated energy demand of the development has been calculated using Standard Assessment Procedure (SAP 2012) methodology. SAP calculates the regulated energy demands for residential dwellings.
- 4.2** SAP calculations have been carried out for representative dwelling types, which encompass ground, mid and top floor flats of different orientations. These represent a fair aggregation of the unit mix of the development. The accommodation schedule has been used to extrapolate the results to represent the energy performance of the whole scheme.
- 4.3** It is recognised that the current carbon emission factors within SAP 2012 methodology for electricity are out of date, and do not reflect the decarbonisation of the electricity Grid. The guidance set out in the Sustainable Design and Construction SPD recommends that the CO₂ emission performance of the Proposed Development could be assessed using “SAP 10” carbon emission factors.
- 4.4** The estimated CO₂ emissions presented throughout this report are assuming SAP 10 emission factors are used. However, estimated CO₂ performance using SAP 2012 carbon emission factors is also presented in Appendix A for comparison. This shows that the proposed energy strategy also meets minimum Part L 2013 CO₂ and fabric energy efficiency requirements.
- 4.5** In line with guidance in the Sustainable Design and Construction SPD, the Greater London Authority (GLA)’s Carbon Emissions Reporting Spreadsheet has been used to convert the predicted carbon performance to SAP 10 carbon emission factors. The summary of these calculations is shown in Appendix B.
- 4.6** The unregulated energy demands for the development have been calculated using the methodology outlined in the SAP 2012 document (version 9.92 – October 2013). This calculates the CO₂ emissions associated with appliances and cooking.

Baseline Carbon Emissions

- 4.7** Table 1, below, shows the baseline Regulated and Unregulated CO₂ emissions for the development, based on SAP 10.1 carbon emission factors. TER Worksheets supporting these calculations are shown in Appendix C.

Table 1: Carbon Dioxide Emissions Baseline (SAP 10 Carbon Emission Factors)

	Regulated [TCO ₂ /year]	Unregulated [TCO ₂ /year]	Total [TCO ₂ /year]
Residential	42	27	69

- 4.8 In addition to the CO₂ requirements, residential areas are also required to meet the Target Fabric Energy Efficiency (TFEE) requirement. A floor weighted average TFEE of **49.1 kWh/m²/year** has been calculated for the development. A summary of these calculations is presented in Appendix A.

5. DEMAND REDUCTION – ENERGY EFFICIENCY

Building Fabric

5.1 The first stage of the Energy Hierarchy is demand reduction from fabric energy efficiency measures. The following fabric energy efficiency targets have been assumed to estimate the energy performance for the proposed development:

- > External wall U-values of $0.18 \text{ W/m}^2\text{K}$;
- > Corridor wall U-values of $0.18 \text{ W/m}^2\text{K}$;
- > Ground and exposed floor U-values of $0.15 \text{ W/m}^2\text{K}$;
- > Main flat roof U value of $0.12 \text{ W/m}^2\text{K}$;
- > Double glazing with a U-value of $1.2 \text{ W/m}^2\text{K}$;
- > 100% low energy efficiency lighting.

Air Tightness and Ventilation

5.2 It is proposed that all dwellings are fitted with a **Mechanical Ventilation with Heat Recovery (MVHR)** system. This system provides a whole dwelling ventilation system that supplies and extracts air, reusing heat that would have been lost, as illustrated in Figure 4. The dwelling MVHR unit should target a specific fan power (SFP) of $0.60\text{-}0.68 \text{ W/l/s}$ (depending on the number of wet rooms), and an efficiency above 88%.

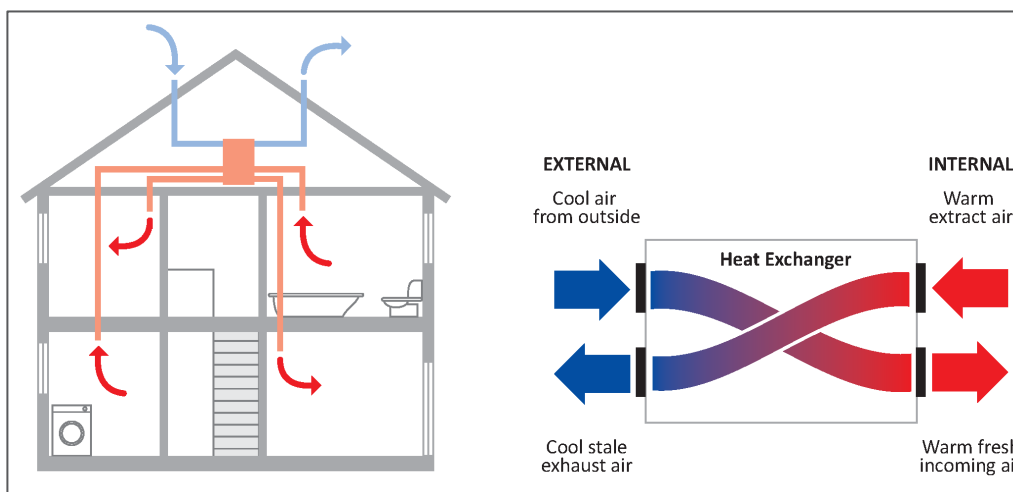


Figure 4: Mechanical Ventilation with Heat Recovery

- 5.3** All dwellings will be air tested on completion and have an air permeability target of **3m³/hr.m²**.
- 5.4** Additionally, to minimise summer overheating risk, all dwellings will have openable windows where possible and be able to naturally ventilate where required. This will facilitate convective ventilation and night purging of heat.

Thermal Bridging

- 5.5** In well insulated buildings, as much as 30% of heat loss can occur through thermal bridges, which arise when elements are disrupted by changes in construction or penetration through the insulation layer, as shown in Figure 5.

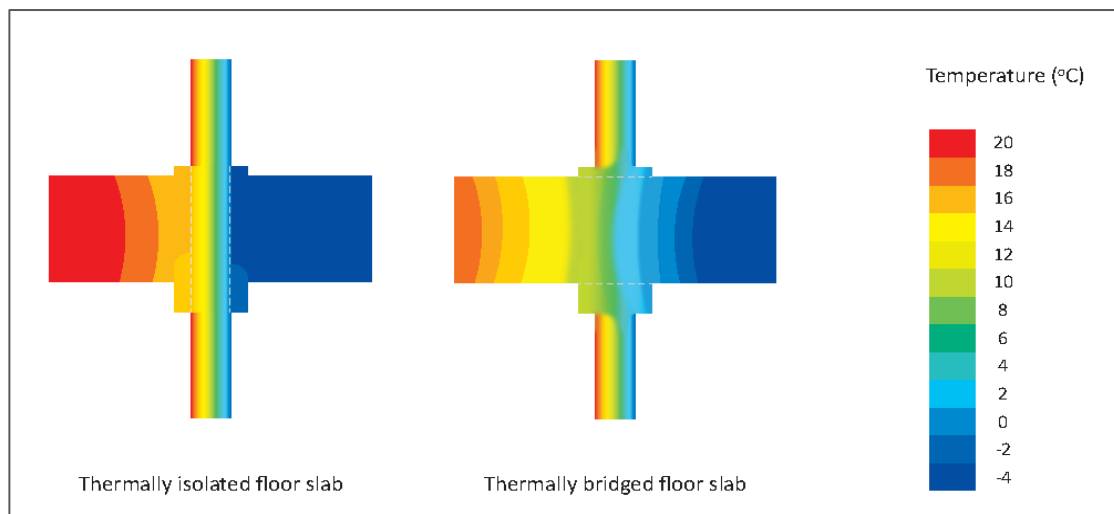


Figure 5: Thermal Bridging

- 5.6** Part L1A places increased importance on addressing heat losses through thermal bridging. As such, the applicant is committed to develop a building fabric where these are minimised as far as practical. It is assumed that Accredited Construction Details (ACDs) will be used where possible. These psi values are summarised in Table 2, below. Where an ACD is not available, the default psi value will be used.

Table 2: Indicative Thermal Bridging Psi Value Targets

SAP Ref.	Junction	Default value	ACD value
E1	Lintels	1	0.3
E3	Sill	0.08	0.04
E4	Jamb	0.1	0.05
E20	Exposed floor to external wall	0.32	N/A – default assumed
E7	Intermediate Floor	0.14	0.07
E23	Balconies	1	N/A – default assumed
E15	Flat roof with parapet	0.56	0.28
E16	External corner	0.18	0.09
E17	Inverted corner	0.00	-0.09
E18	Party corner	0.12	0.06
P7	Party exposed floor	0.16	N/A – default assumed
P4	Party roof	0.24	0.12

Space Heating and Hot Water

- 5.7** It is assumed that the heating and hot water for the development will be supplied by a direct acting electric boiler.
- 5.8** Supplying the heating and hot water demand from an electric based system will enable the CO₂ emissions of the proposed development to continue to decrease in the future with the expected ongoing decarbonisation of the electricity Grid.
- 5.9** This is in recognition that by 2025 it is expected that new build developments could be required to be gas-free.

Unregulated Energy Demands

- 5.10** Unregulated energy demands can be energy needed for cooking and powering appliances within the home. The energy associated with these uses are dependent on the occupant of the 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 energy consumption.

Minimising Summer Overheating

- 5.11** Minimising solar gains within dwellings can help to reduce the risk of summer overheating, although, this should be balanced with maximising solar gains in the winter. This can be optimised through orientation of dwellings, solar shading, external shading, design and thermal mass.
- 5.12** Good ventilation in the dwellings and fully openable windows where possible also help to mitigate overheating risk in the summer months.
- 5.13** The assessed dwellings meet Criterion 3 of Approved Document L1A.

CO₂ Emissions following Energy Efficiency Measures

- 5.14** Table 3, below, shows the site wide estimated Regulated CO₂ emissions following the **energy efficiency** measures outlined above. These measures result in a CO₂ emissions reduction of **22%** over the Part L 2013 baseline for residential development, using SAP 10 carbon emission factors. A summary of these calculations is shown in Appendix B.
- 5.15** For comparison, estimated CO₂ emissions using SAP 2012 carbon emission factors can be found in Appendix A. DER worksheets supporting these calculations are shown in Appendix D.

Table 3: Regulated Carbon Dioxide Emissions following <i>Be Lean</i>		
Stage	Carbon Dioxide Emissions (Tonnes CO ₂ per Annum)	% Reduction
Baseline: Part L 2013	42	-
After <i>energy efficiency</i> measures	66	22%

- 5.16** The floor weighted average Dwelling Fabric Energy Efficiency (DFEE) has been calculated as **41.4 kWh/m²/year**. This represents a **15.6%** improvement over the calculated TFEE, this is shown in Table 4, below. A summary of these calculations is shown in Appendix A.

Table 4: Fabric Energy Efficiency			
	Target Fabric Energy Efficiency (kWh/m ² /year)	Design Fabric Energy Efficiency (kWh/m ² /year)	Improvement (%)
Development Total	49.1	41.4	15.6%

6. HEATING INFRASTRUCTURE

- 6.1 Policy CC4: Decentralised Energy in the Reading Borough Council's Local Plan requires that any development of more than 20 dwellings should consider the inclusion of decentralised energy provision, unless it can be demonstrated that the scheme is not suitable, feasible or viable.
- 6.2 A heat mapping and energy master planning study for Reading town centre was undertaken by Element Energy for Reading Borough Council. This outlined four main cluster areas that could be suitable for heat network schemes.
- 6.3 Figure 6, below, outlines the 4 main clusters. This is taken from the Sustainable Design and Construction SPD. The proposed development falls within the "Station Hill and around" cluster.

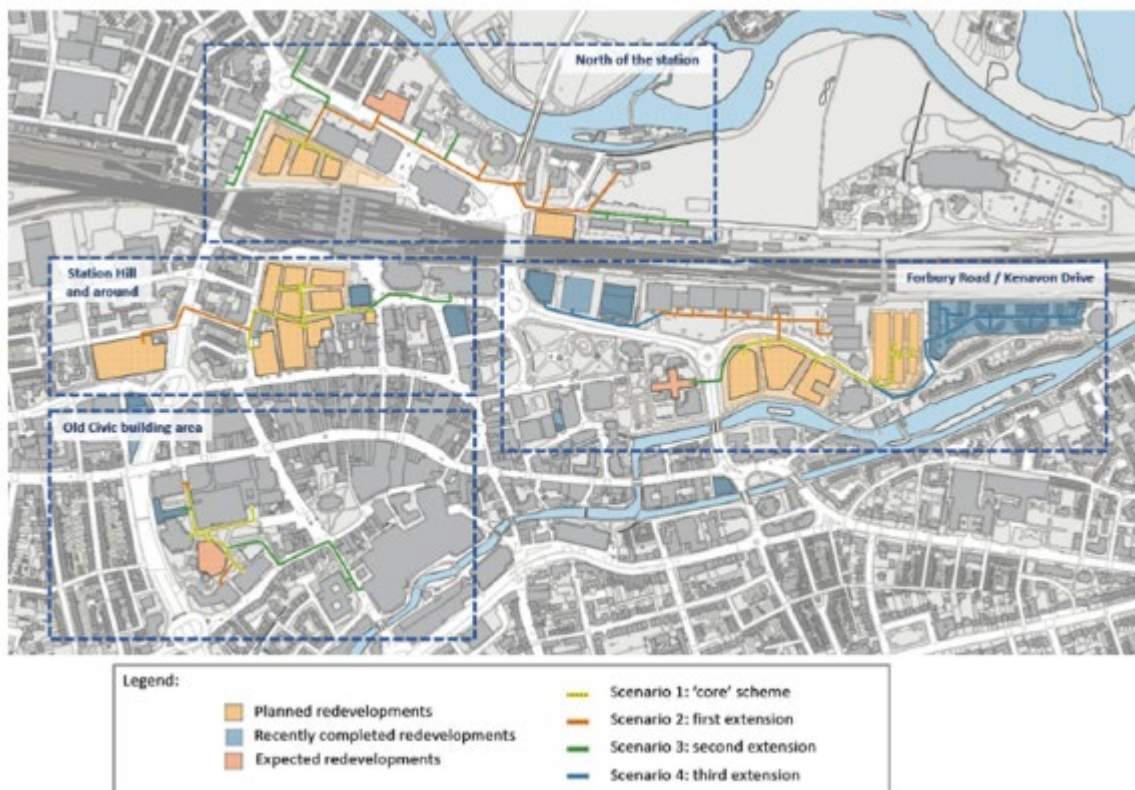


Figure 6: Overview of the four identified clusters (Element Energy)

- 6.4 Despite being within one of the clusters, there are no known existing or planned heat networks in close proximity to the proposed development to be connected to. As the development is only for 40 dwellings, it is not considered cost-effective to install a site-wide network, as the costs to residents would be high. Due to the small scale of the development, a communal heat network has not been proposed for the following reasons:

- > **Site Location** – as there are no known heat networks in close proximity to the development, it is not feasible to connect to an existing heat network.
- > **Installation and running costs** – the costs of the heat network are likely to be split between the dwellings on the development. The low density of dwellings means that this cost would be significantly higher to residents compared to an individual system.
- > **Diversity of demand** – heat networks are best suited to developments that have a large diversity of energy demand. On small developments such as this, there could be long periods of low heat demand with short sharp peaks in heat demand. This could result in waste energy being produced from the network.

7. RENEWABLE ENERGY TECHNOLOGIES

- 7.1 The final stage of the Energy Hierarchy is the inclusion of renewable energy technologies where feasible to provide a reduction in expected carbon dioxide emissions. The feasibility of the following renewable energy technologies has been considered for this development.

Wind Turbines

- 7.2 The Proposed Development is situated in an urban location. It has been shown that such locations often experience highly turbulent and low speed wind conditions. The installation of wind turbines would not be a technically appropriate or cost-effective method for the generation of renewable energy and have not been proposed for this development.

Biomass Boiler

- 7.3 Biomass boilers with modern pollution abatement devices can almost eliminate particulate matter emissions and can also be very low on emissions of NOx.
- 7.4 However, biomass boilers are best designed at a community scale. As previously discussed, heat networks require a larger number of dwellings to spread the cost and provide a more regular energy demand. This development has an insufficient number of dwellings for a communal biomass network to be cost and energy efficient, and has not been proposed.

Air and Ground Source Heat Pumps

- 7.5 Heat pumps upgrade low-grade heat from the ground or air and utilise it for space heating and hot water. They can provide substantial reductions in energy.
- 7.6 Ground Source Heat Pumps (GSHPs) require costly ground excavation works to bury the coils, and have not been considered for this development due to the high capital costs and complexities associated with it. It is also a brownfield site which adds further complexities. Air Source Heat Pumps (ASHPs) are a more economical alternative.
- 7.7 Due to the small size of the development, individual air source heat pumps would be most suitable. However, there is limited external space that is required for the external heat pump units for each dwelling. There are also concerns of noise issues associated with the units. Due to the limited space available and complexities in design, ASHPs have not been proposed for the development.

Solar Thermal (hot water) Panels

- 7.8 Solar thermal panels use the sun's radiant heat to generate hot water for each dwelling. Due to the seasonality of solar radiation, solar thermal panels can provide up to ~60% of a dwelling's hot water

demand. They are, however, not an independent technology and will require fully-sized heating plant within the dwelling.

- 7.9** Due to the additional plant required, solar thermal panels are not proposed for the development, as Solar PV (outlined below) is considered more appropriate.

Photovoltaic (PV) Panels

- 7.10** PV panels generate electricity from solar radiation. The generating potential of PV panels is dependent on the availability of roof space and ensuring that they are not over-shaded.
- 7.11** It is proposed to install 30 kWp to the development, which would maximise the roof space available taking into consideration the size of panels and the appropriate spacing required between panels to allow for access and maintenance. Panels should be tilted slightly at 10° and orientated towards the South to optimise output.

CO₂ Emissions following Renewable Energy Measures

- 7.12** Table 5, below, shows the CO₂ reduction expected from the proposed renewable technologies outline in the section above. This would result in a further **13%** CO₂ reduction over the **energy efficiency** stage of the hierarchy, calculated using SAP 10 carbon emission factors. A summary of these calculations is show in Appendix B. Following this stage, the development is achieving an overall site-wide 35% CO₂ reduction over a Part L 2013 baseline, using SAP 10 carbon emission factors.

Table 5: Regulated Carbon Dioxide Emissions Reduction following Renewable Energy Measures

Stage	Carbon Dioxide Emissions (Tonnes CO ₂ per Annum)	% Reduction
Part L 2013 Baseline	42	
After <i>Energy Efficiency</i> Measures	33	22%
After <i>Renewable Energy</i> Measures	28	13%
Cumulative Saving	14	35%

- 7.13** For comparison, a summary of the CO₂ emissions estimated using SAP 2012 carbon emission factors is shown in Appendix A. This shows that with the proposed energy strategy, minimum current Part L 2013 CO₂ and fabric energy efficiency requirements are also achieved.

8. ZERO CARBON

- 8.1 In line with Policy H5: Standards for new housing in Reading Borough Council's Local Plan, all major new-build developments (over 10 dwellings) should be designed to achieve *zero carbon homes*. Where this cannot be met on-site, any residual CO₂ can be offset to a payment to Reading Borough Council to go towards carbon offsetting elsewhere within Reading.
- 8.2 The policy indicates that a carbon offsetting price of £60 per tonne of residual Regulated CO₂ per year, for a period of 30 years.
- 8.3 The estimated remaining Regulated CO₂ emissions after the **Be Lean** and **Be Green** stages of the Energy Hierarchy, using SAP 10 carbon emission factors, are calculated to be **28 tonnes CO₂ per annum**. Therefore, the estimated payment due to Reading Borough Council is **£50,400**.
- 8.4 These calculations should be refined at the detailed design stage of the development.

9. SUMMARY

- 9.1** The purpose of this document is to outline the proposed energy strategy for the proposed development at 45 Caversham Road, by Elstree Land Ltd. The energy strategy has been formulated following the Energy Hierarchy, reducing energy demand through energy efficiency measures, before considering the inclusion of a decentralised energy supply and renewable energy technologies.
- 9.2** The proposed development is for 40 new-build residential dwellings.
- 9.3** In line with Reading Borough Council's Sustainable Design and Construction SPD, the predicted CO₂ emissions of the proposed development have been estimated using both SAP 2012 and updated SAP 10 carbon emission factors. The figures presented throughout the main report have been calculated using SAP 10 carbon emission factors, as these are considered a more accurate representation of carbon dioxide emissions. However, performance using SAP 2012 carbon emission factors are also presented in the Appendix.
- 9.4** A range of advance **Energy Efficiency** measures are proposed. Along with an electric boiler heating strategy, this allows the development to achieve a **22%** CO₂ reduction over a Part L 2013 baseline.
- 9.5** In line with Reading Borough Council's Local Plan, the feasibility of a decentralised energy production has been considered. There are no known heat networks in close proximity of the development, and due to the small scale of the development, it is not considered feasible to install a site-wide network. It is proposed that the heating and hot water is supplied by electric boilers.
- 9.6** A range of **Renewable Energy Technologies** has been considered. It is proposed to maximise the roof space available to provide 30 kWp of Solar PV to the proposed development. This provides a further **13%** reduction in Regulated CO₂ emissions over the first stage of the Energy Hierarchy.
- 9.7** Table 6, below, summarises the anticipated CO₂ emissions of the proposed development following the **Energy Efficiency** and **Renewable Energy Technology** measures proposed. The combination of these measures results in an on-site **35%** CO₂ reduction over a Part L 2013 baseline, using SAP 10 carbon emission factors.
- 9.8** In line with Reading Borough Council's Local Plan, any residual CO₂ emissions will be offset so the development achieves zero carbon homes standard. The offsetting price is calculated as £60 per tonne of CO₂ over a period of 30 years. The estimated remaining Regulated CO₂ emissions are calculated to be **28 Tonnes CO₂ per annum**, resulting in a carbon offset payment of **£50,400**.

Table 6: Total Site-Wide Regulated Carbon Dioxide Emissions

Stage	Carbon Dioxide Emissions (Tonnes CO ₂ per Annum)	% Reduction
Part L 2013 Baseline	42	-
After <i>Energy Efficiency</i> Measures	33	22%
After <i>Renewable Technology</i> Measures	28	13%
Cumulative Saving	15	35%

APPENDICES

Appendix A

CO₂ Emissions & FEE Summary – SAP 2012 Emission Factors

Appendix B

CO₂ Emissions Summary – SAP 10 Emission Factors

Appendix C

TER Worksheets

Appendix D

DER Worksheets – *Be Lean*

Appendix A

CO₂ Emissions and FEE Summary – *SAP 2012 Emission Factors*

CO₂ Emissions with Renewable Energy Technologies

Unit Type Description	Unit Floor Area	Individual		Number of Units	Total			Emissions Rate Improvement
		Dwelling Emissions Rate	Target Emissions Rate		Total Floor Area	Dwelling Emissions Rate	Target Emissions Rate	
	m ²	kg CO ₂ /m ² /year	kg CO ₂ /m ² /year		m ²	kg CO ₂ /year	kg CO ₂ /year	-
Domestic								
1B2P Mid GF	54	30.9	29.0	4	217	6,707	6,282	-6.8%
2B3P End GF	52	24.7	23.7	7	365	9,013	8,656	-4.1%
A205 1B2P Mid MF	73	31.8	28.3	12	879	27,990	24,833	-12.7%
A205 1B2P Mid TF	73	24.7	23.6	10	733	18,117	17,304	-4.7%
A209 1B2P End MF	62	27.4	25.7	4	248	6,791	6,370	-6.6%
B08 2B3P End MF	65	22.6	22.7	8	519	11,738	11,775	0.3%
B08 2B3P End TF	75	31.4	29.7	6	452	14,189	13,426	-5.7%
B10 2B3P Mid MF	76	33.7	31.6	8	604	20,354	19,094	-6.6%
Total CO ₂ Emissions Offset by PV						11,841		
Total for All Units					4,016	103,058	107,740	4.3%

Fabric Energy Efficiency

Unit Type Description	Unit Floor Area	<u>Individual</u>		Number of Units	<u>Total</u>			Fabric Energy Efficiency Improvement
		Dwelling Fabric Energy Efficiency	Target Fabric Energy Efficiency		Total Floor Area	Dwelling Fabric Energy Efficiency	Target Fabric Energy Efficiency	
	m ²	kWh/m ² /year	kWh/m ² /year		m ²	kWh/year	kWh/year	-
1B2P Mid GF	54	42.3	50.8	4	217	9,177	11,020	16.7%
2B3P End GF	52	27.8	29.8	7	365	10,167	10,896	6.7%
A205 1B2P Mid MF	73	49.6	55.8	12	879	43,612	49,005	11.0%
A205 1B2P Mid TF	73	35.3	40.4	10	733	25,891	29,613	12.6%
A209 1B2P End MF	62	37.4	43.2	4	248	9,274	10,702	13.3%
B08 2B3P End MF	65	27.7	34.7	8	519	14,395	18,036	20.2%
B08 2B3P End TF	75	48.7	61.0	6	452	21,998	27,549	20.1%
B10 2B3P Mid MF	76	52.8	67.0	8	604	31,918	40,448	21.1%
Floor Weighted Average				59	4,016	41.4	49.1	15.6%

Appendix B

CO₂ Emissions Summary – *SAP 10 Emission Factors*

SAP10 PERFORMANCE

Table 1: Carbon Dioxide Emissions after each stage of the Energy Hierarchy for domestic buildings

	Carbon Dioxide Emissions for domestic buildings (Tonnes CO ₂ per annum)	
	Regulated	Unregulated
Baseline: Part L 2013 of the Building Regulations Compliant Development	42	27
After energy demand reduction	33	27
After heat network / CHP	33	27
After renewable energy	28	27

Table 2: Regulated Carbon Dioxide savings from each stage of the Energy Hierarchy for domestic buildings

	Regulated domestic carbon dioxide savings	
	(Tonnes CO ₂ per annum)	(%)
Savings from energy demand reduction	10	22%
Savings from heat network / CHP	0	0%
Savings from renewable energy	5	13%
Cumulative on site savings	15	35%
Annual savings from off-set payment	28	-
	(Tonnes CO ₂)	
Cumulative savings for off-set payment	828	-
Cash in-lieu contribution (£)	49,680	

Appendix C

TER Worksheets

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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	22/09/2020
Address	1BA2 GF Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	54.20 (1a) x	2.50 (2a) =	135.50 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 54.20 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	135.50 (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 fuelless 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) = 0.15 (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)	0.40 (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) = 0.34 (21)
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Infiltration rate modified for monthly wind speed:

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

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18
-----------------------	------	------	------	------	------	------	------	------	------	------	------	------

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	0.34	0.36	0.38	0.40
---	------	------	------	------	------	------	------	------	------	------	------	------

Calculate effective air change rate for the applicable case:

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

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

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

0.59	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.57	0.58
------	------	------	------	------	------	------	------	------	------	------	------

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			2.12 x	1.00 =	2.12		(26)
Window			11.42 x	1.33 =	15.14		(27)
Ground floor			54.20 x	0.13 =	7.05		(28a)
External wall			47.48 x	0.18 =	8.55		(29a)
Party wall			19.44 x	0.00 =	0.00		(32)
Total area of external elements ΣA, m ²			115.22				(31)
Fabric heat loss, W/K = Σ(A x U)						(26)...(30) + (32) =	32.85 (33)
Heat capacity Cm = Σ(A x k)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m ² K							250.00 (35)
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							8.95 (36)
Total fabric heat loss						(33) + (36) =	41.81 (37)

Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	26.51	26.35	26.19	25.45	25.31	24.66	24.66	24.54	24.91	25.31	25.59	25.88
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Heat transfer coefficient, W/K (37)m + (38)m	68.31	68.15	68.00	67.25	67.11	66.47	66.47	66.35	66.72	67.11	67.40	67.69
Average = Σ(39)1...12/12 =	67.25 (39)											

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.26	1.26	1.25	1.24	1.24	1.23	1.23	1.22	1.23	1.24	1.24	1.25
Average = Σ(40)1...12/12 =	1.24 (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	1.81 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	77.28 (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)	85.01	81.92	78.83	75.73	72.64	69.55	69.55	72.64	75.73	78.83	81.92	85.01
Σ(44)1...12 =	927.36 (44)											

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	126.06	110.26	113.77	99.19	95.18	82.13	76.11	87.33	88.38	102.99	112.42	122.09
Σ(45)1...12 =	1215.91 (45)											

Distribution loss 0.15 x (45)m	18.91	16.54	17.07	14.88	14.28	12.32	11.42	13.10	13.26	15.45	16.86	18.31
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Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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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
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Combi loss for each month from Table 3a, 3b or 3c	43.32	37.70	40.17	37.35	37.02	34.30	35.44	37.02	37.35	40.17	40.40	43.32
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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	169.38	147.96	153.94	136.54	132.19	116.43	111.55	124.35	125.72	143.16	152.82	165.41
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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
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Output from water heater for each month (kWh/month) (62)m + (63)m

169.38	147.96	153.94	136.54	132.19	116.43	111.55	124.35	125.72	143.16	152.82	165.41
$\Sigma(64)1...12 =$											1679.46

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

52.75	46.09	47.87	42.32	40.90	35.88	34.17	38.29	38.72	44.29	47.48	51.42
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5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains (Table 5)											
90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69

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

14.13	12.55	10.21	7.73	5.78	4.88	5.27	6.85	9.19	11.67	13.63	14.52
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

158.12	159.76	155.63	146.83	135.71	125.27	118.29	116.65	120.79	129.59	140.70	151.14
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Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07
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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
------	------	------	------	------	------	------	------	------	------	------	------

Losses e.g. evaporation (Table 5)

-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56
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Water heating gains (Table 5)

70.90	68.58	64.34	58.78	54.97	49.84	45.92	51.47	53.78	59.53	65.95	69.12
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

296.36	294.10	283.39	266.54	249.67	233.19	222.69	228.18	236.97	254.00	273.48	288.00
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6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W
SouthEast	0.77	11.42	36.79	0.63	0.70	128.41

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

128.41	218.74	299.29	370.83	415.36	412.36	397.55	364.33	324.06	241.75	153.81	109.90
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Total gains - internal and solar (73)m + (83)m

424.77	512.84	582.67	637.37	665.03	645.55	620.25	592.51	561.03	495.75	427.29	397.89
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7. Mean internal temperature (heating season)

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

21.00

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

0.99	0.98	0.96	0.91	0.80	0.63	0.46	0.50	0.74	0.93	0.99	1.00
------	------	------	------	------	------	------	------	------	------	------	------

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

19.78	19.99	20.28	20.60	20.84	20.96	20.99	20.99	20.92	20.60	20.12	19.74
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

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

19.87	19.87	19.88	19.89	19.89	19.90	19.90	19.90	19.90	19.89	19.89	19.88
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.98	0.95	0.88	0.74	0.53	0.35	0.39	0.65	0.91	0.98	0.99
------	------	------	------	------	------	------	------	------	------	------	------

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

18.27	18.58	18.99	19.44	19.74	19.88	19.90	19.90	19.84	19.45	18.78	18.22
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

Living area fraction

Living area ÷ (4) =

0.44

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

18.93	19.20	19.55	19.95	20.22	20.35	20.37	20.37	20.31	19.95	19.37	18.88
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

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

18.93	19.20	19.55	19.95	20.22	20.35	20.37	20.37	20.31	19.95	19.37	18.88
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation factor for gains, ηm											
0.99	0.98	0.95	0.88	0.76	0.57	0.40	0.44	0.68	0.91	0.98	0.99

Useful gains, ηmGm, W (94)m x (84)m

420.26	500.49	552.08	562.37	504.33	368.80	248.91	260.56	383.30	449.85	417.94	394.67
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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
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

999.48	974.55	887.57	743.06	572.01	382.21	250.90	263.63	414.28	627.74	826.70	993.88
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Space heating requirement, kWh/month $0.024 \times [(97)m - (95)m] \times (41)m$

430.94	318.57	249.61	130.10	50.36	0.00	0.00	0.00	0.00	132.35	294.31	445.82
--------	--------	--------	--------	-------	------	------	------	------	--------	--------	--------

$\Sigma(98)1...5, 10...12 =$

2052.06

Space heating requirement kWh/m²/year

(98) ÷ (4) =

37.86

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 (%)

93.40

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month											
461.39	341.08	267.24	139.29	53.92	0.00	0.00	0.00	0.00	141.70	315.11	477.32
$\Sigma(211)1...5, 10...12 =$											2197.06

Water heating											
Efficiency of water heater											
87.30	86.93	86.26	84.93	82.85	80.30	80.30	80.30	80.30	84.85	86.67	87.42

Water heating fuel, kWh/month

194.02	170.20	178.46	160.77	159.55	144.99	138.91	154.86	156.57	168.71	176.32	189.20
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

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

1992.57

Annual totals

Space heating fuel - main system 1

2197.06

Water heating fuel

1992.57

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

central heating pump or water pump within warm air heating unit

30.00

boiler flue fan

45.00

Total electricity for the above, kWh/year

75.00

Electricity for lighting (Appendix L)

249.58

Total delivered energy for all uses

(211)...(221) + (231) + (232)...(237b) = 4514.21 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2197.06	x	3.48	x 0.01 =	76.46	(240)
Water heating	1992.57	x	3.48	x 0.01 =	69.34	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	249.58	x	13.19	x 0.01 =	32.92	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		308.61	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.31	(257)
SAP value	81.77	
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	2197.06	x	0.216	=	474.57	(261)
Water heating	1992.57	x	0.216	=	430.39	(264)
Space and water heating			(261) + (262) + (263) + (264) =		904.96	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	249.58	x	0.519	=	129.53	(268)
Total CO ₂ , kg/year			(265)...(271) =		1073.42	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		19.80	(273)
EI value					85.50	
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	2197.06	x	1.22	=	2680.41	(261)
Water heating	1992.57	x	1.22	=	2430.93	(264)
Space and water heating			(261) + (262) + (263) + (264) =		5111.35	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	249.58	x	3.07	=	766.20	(268)
Primary energy kWh/year					6107.80	(272)
Dwelling primary energy rate kWh/m ² /year					112.69	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	22/09/2020
Address	18A7 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)	
Lowest occupied	52.20	(1a)	x	2.50	(2a)	= 130.50 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 52.20	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =	130.50	(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) =	0.15	(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			5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.40	(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) =	0.31	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
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, 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			2.12	x 1.00	= 2.12		(26)						
Window			6.33	x 1.33	= 8.39		(27)						
External wall			35.29	x 0.18	= 6.35		(29a)						
Party wall			45.60	x 0.00	= 0.00		(32)						
Total area of external elements ΣA, m ²			43.74				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	16.86	(33)						
Heat capacity Cm = Σ(A × κ)					(28)...(30) + (32) + (32a)...(32e) =	N/A	(34)						
Thermal mass parameter (TMP) in kJ/m ² K						250.00	(35)						
Thermal bridges: Σ(L × Ψ) calculated using Appendix K						3.78	(36)						
Total fabric heat loss					(33) + (36) =	20.64	(37)						
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	24.95	24.82	24.69	24.08	23.96	23.43	23.43	23.33	23.64	23.96	24.19	24.44	(38)
Heat transfer coefficient, W/K (37)m + (38)m	45.60	45.46	45.33	44.72	44.61	44.07	44.07	43.98	44.28	44.61	44.84	45.08	
	Average = Σ(39)1...12/12 = 44.72 (39)												
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.87	0.87	0.87	0.86	0.85	0.84	0.84	0.84	0.85	0.85	0.86	0.86	
	Average = Σ(40)1...12/12 = 0.86 (40)												
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N	1.75	(42)											
Annual average hot water usage in litres per day Vd,average = (25 × N) + 36	75.88	(43)											
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	83.47	80.43	77.40	74.36	71.33	68.29	68.29	71.33	74.36	77.40	80.43	83.47	
	Σ(44)1...12 = 910.57 (44)												
Energy content of hot water used = 4.18 × Vd,m × nm × Tm/3600 kWh/month (see Tables 1b, 1c 1d)	123.78	108.26	111.71	97.40	93.45	80.64	74.73	85.75	86.78	101.13	110.39	119.88	
	Σ(45)1...12 = 1193.90 (45)												
Distribution loss 0.15 x (45)m	18.57	16.24	16.76	14.61	14.02	12.10	11.21	12.86	13.02	15.17	16.56	17.98	(46)
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)
Combi loss for each month from Table 3a, 3b or 3c	42.53	37.02	39.44	36.67	36.35	33.68	34.80	36.35	36.67	39.44	39.67	42.53	(61)
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m	166.32	145.28	151.16	134.07	129.80	114.32	109.53	122.10	123.45	140.57	150.06	162.41	(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)
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Output from water heater for each month (kWh/month) (62)m + (63)m

166.32	145.28	151.16	134.07	129.80	114.32	109.53	122.10	123.45	140.57	150.06	162.41		
Σ(64)1...12 = 1649.06 (64)													

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

51.79	45.25	47.01	41.55	40.16	35.23	33.55	37.60	38.02	43.49	46.62	50.49	(65)
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5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	15.10	13.41	10.91	8.26	6.17	5.21	5.63	7.32	9.82	12.47	14.56	15.52	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	152.94	154.53	150.53	142.02	131.27	121.17	114.42	112.83	116.83	125.35	136.09	146.20	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	(71)
Water heating gains (Table 5)	69.61	67.34	63.18	57.71	53.98	48.94	45.09	50.54	52.81	58.45	64.75	67.87	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	289.98	287.61	276.94	260.31	243.75	227.64	217.47	223.01	231.79	248.59	267.73	281.91	(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							
South	0.77	x 6.33	x 46.75	x 0.9 x 0.63	x 0.70	= 90.44 (78)							
Solar gains in watts Σ(74)m...(82)m	90.44	148.12	188.68	213.25	222.22	213.86	208.95	202.92	197.10	159.76	107.21	78.15	(83)
Total gains - internal and solar (73)m + (83)m	380.42	435.73	465.63	473.56	465.97	441.50	426.42	425.94	428.89	408.36	374.93	360.06	(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	0.96	0.92	0.81	0.63	0.45	0.47	0.69	0.91	0.98	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.27	20.43	20.60	20.80	20.93	20.99	21.00	21.00	20.98	20.83	20.52	20.24	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	20.19	20.19	20.19	20.20	20.21	20.22	20.22	20.22	20.21	20.21	20.20	20.20	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.98	0.95	0.89	0.76	0.55	0.37	0.39	0.62	0.89	0.98	0.99	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	19.23	19.45	19.70	19.97	20.14	20.21	20.21	20.22	20.20	20.02	19.59	19.19	(90)

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

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

19.71	19.90	20.12	20.35	20.50	20.57	20.58	20.56	20.39	20.02	19.67	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.71	19.90	20.12	20.35	20.50	20.57	20.58	20.56	20.39	20.02	19.67	(93)
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8. Space heating requirement

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

0.99	0.98	0.95	0.90	0.78	0.59	0.41	0.43	0.65	0.89	0.98	0.99	(94)
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Useful gains, ηmGm, W (94)m x (84)m

376.72	426.06	443.66	424.45	364.01	259.21	174.88	183.19	278.60	364.43	366.37	357.44	(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]

702.53	681.81	617.34	512.09	392.64	262.99	175.20	183.63	285.90	436.74	579.11	697.53	(97)
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Space heating requirement, kWh/month 0.024 x ((97)m - (95)m) x (41)m

242.40	171.86	129.22	63.10	21.30	0.00	0.00	0.00	0.00	53.80	153.17	253.02
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$\Sigma(98)1...5, 10...12 =$ (98)

Space heating requirement kWh/m²/year

$(98) \div (4) =$ (99)

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

Space heating

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

(201)

Fraction of space heat from main system(s)

1 - (201) = (202)

Fraction of space heat from main system 2

(202)

Fraction of total space heat from main system 1

(202) x [1 - (203)] = (204)

Fraction of total space heat from main system 2

(202) x (203) = (205)

Efficiency of main system 1 (%)

(206)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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Space heating fuel (main system 1), kWh/month

259.53	184.00	138.35	67.56	22.81	0.00	0.00	0.00	0.00	57.60	163.99	270.90
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$\Sigma(211)1...5, 10...12 =$ (211)

Water heating

Efficiency of water heater

86.00	85.48	84.66	83.28	81.58	80.30	80.30	80.30	80.30	82.86	85.10	86.16	(217)
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Water heating fuel, kWh/month

193.39	169.97	178.55	160.99	159.10	142.37	136.40	152.05	153.73	169.64	176.32	188.49
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$\Sigma(219a)1...12 =$ (219)

Annual totals

Space heating fuel - main system 1

Water heating fuel

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

central heating pump or water pump within warm air heating unit

(230c)

boiler flue fan

(230e)

Total electricity for the above, kWh/year

(231)

Electricity for lighting (Appendix L)

(232)

Total delivered energy for all uses

$(211)...(221) + (231) + (232)...(237b) =$ (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year
Space heating - main system 1	1164.75	x	3.48	x 0.01 =	40.53 (240)
Water heating	1981.01	x	3.48	x 0.01 =	68.94 (247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89 (249)
Electricity for lighting	266.66	x	13.19	x 0.01 =	35.17 (250)
Additional standing charges					120.00 (251)
Total energy cost				(240)...(242) + (245)...(254) =	274.54 (255)

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

Energy cost deflator (Table 12)	0.42 (256)
Energy cost factor (ECF)	1.19 (257)
SAP value	83.45
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	1164.75	x	0.216	=	251.59 (261)
Water heating	1981.01	x	0.216	=	427.90 (264)
Space and water heating			(261) + (262) + (263) + (264) =		679.48 (265)
Pumps and fans	75.00	x	0.519	=	38.93 (267)
Electricity for lighting	266.66	x	0.519	=	138.40 (268)
Total CO ₂ , kg/year				(265)...(271) =	856.80 (272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	16.41 (273)
EI value					88.19
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	1164.75	x	1.22	=	1420.99 (261)
Water heating	1981.01	x	1.22	=	2416.83 (264)
Space and water heating			(261) + (262) + (263) + (264) =		3837.82 (265)
Pumps and fans	75.00	x	3.07	=	230.25 (267)
Electricity for lighting	266.66	x	3.07	=	818.65 (268)
Primary energy kWh/year					4886.72 (272)
Dwelling primary energy rate kWh/m ² /year					93.62 (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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	22/09/2020
Address	2BA8 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	62.00 (1a) x	2.50 (2a) =	155.00 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 62.00 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	155.00 (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) =	0.13 (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, 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) =	0.32 (21)
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Infiltration rate modified for monthly wind speed:

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

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.93	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	0.41	0.40	0.39	0.35	0.31	0.31	0.30	0.32	0.35	0.36	0.38
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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	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.57	0.57
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.58	0.58	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.57	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			2.12	x 1.00	= 2.12		(26)
Window			13.38	x 1.33	= 17.74		(27)
External wall			52.14	x 0.18	= 9.39		(29a)
Party wall			29.84	x 0.00	= 0.00		(32)
Total area of external elements ΣA, m ²			67.64				(31)

Fabric heat loss, W/K = Σ(A x U)	(26)...(30) + (32) =	29.24 (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		250.00 (35)
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Thermal bridges: Σ(L x Ψ) calculated using Appendix K		5.94 (36)
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Total fabric heat loss	(33) + (36) =	35.19 (37)
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)											
29.89	29.72	29.56	28.79	28.64	27.97	27.97	27.85	28.23	28.64	28.93	29.24

Heat transfer coefficient, W/K (37)m + (38)m												
65.08	64.91	64.74	63.97	63.83	63.16	63.16	63.03	63.41	63.83	64.12	64.43	
Average = $\sum(39)1...12/12 =$											63.97	(39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)											
1.05	1.05	1.04	1.03	1.03	1.02	1.02	1.02	1.02	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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4. Water heating energy requirement

Assumed occupancy, N	2.04 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	82.59 (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)											
90.85	87.55	84.24	80.94	77.64	74.33	74.33	77.64	80.94	84.24	87.55	90.85
Σ(44)1...12 =										991.11	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)												
134.73	117.84	121.60	106.01	101.72	87.78	81.34	93.34	94.45	110.07	120.15	130.48	
										Σ(45)1...12 =	1299.50	(45)

Distribution loss 0.15 x (45)m	20.21	17.68	18.24	15.90	15.26	13.17	12.20	14.00	14.17	16.51	18.02	19.57
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Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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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
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Combi loss for each month from Table 3a, 3b or 3c	46.30	40.30	42.93	39.92	39.56	36.66	37.88	39.56	39.92	42.93	43.17	46.30
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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	181.03	158.13	164.53	145.93	141.28	124.43	119.22	132.90	134.37	153.00	163.33	176.78
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Solar DHW input calculated using Appendix G or Appendix H

Total delivered energy for all uses

(211)...(221) + (231) + (232)...(237b) = 4607.10 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2117.62	x	3.48	x 0.01 =	73.69	(240)
Water heating	2133.98	x	3.48	x 0.01 =	74.26	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	280.50	x	13.19	x 0.01 =	37.00	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		314.85	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.24	(257)
SAP value	82.76	
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	2117.62	x	0.216	=	457.41	(261)
Water heating	2133.98	x	0.216	=	460.94	(264)
Space and water heating			(261) + (262) + (263) + (264) =		918.35	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	280.50	x	0.519	=	145.58	(268)
Total CO ₂ , kg/year			(265)...(271) =		1102.85	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		17.79	(273)
EI value					86.19	
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	2117.62	x	1.22	=	2583.50	(261)
Water heating	2133.98	x	1.22	=	2603.45	(264)
Space and water heating			(261) + (262) + (263) + (264) =		5186.95	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	280.50	x	3.07	=	861.14	(268)
Primary energy kWh/year					6278.34	(272)
Dwelling primary energy rate kWh/m ² /year					101.26	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	22/09/2020
Address	2BA9 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)	
Lowest occupied	64.90	(1a)	x	2.50	(2a)	= 162.25 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 64.90	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =	162.25	(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)
<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			5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.37	(18)
Number of sides on which the dwelling is sheltered			2	(19)
Shelter factor		1 - [0.075 x (19)] =	0.85	(20)
Infiltration rate incorporating shelter factor		(18) x (20) =	0.32	(21)

Infiltration rate modified for monthly wind speed:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Monthly average wind speed from Table U2	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70	(22)
Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.40	0.40	0.39	0.35	0.34	0.30	0.30	0.29	0.32	0.34	0.36	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	0.58	0.56	0.55	0.55	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	0.58	0.56	0.56	0.55	0.55	0.54	0.55	0.56	0.56	0.57	(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			2.12	x	1.00	=	2.12	(26)					
Window			14.09	x	1.33	=	18.68	(27)					
External wall			36.04	x	0.18	=	6.49	(29a)					
Party wall			41.18	x	0.00	=	0.00	(32)					
Total area of external elements ΣA, m ²			52.25					(31)					
Fabric heat loss, W/K = Σ(A x U)						(26)...(30) + (32) =	27.29	(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							250.00	(35)					
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							5.64	(36)					
Total fabric heat loss						(33) + (36) =	32.93	(37)					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	31.15	30.98	30.82	30.03	29.89	29.20	29.20	29.08	29.47	29.89	30.18	30.49	(38)
Heat transfer coefficient, W/K (37)m + (38)m	64.08	63.91	63.74	62.96	62.81	62.13	62.13	62.00	62.39	62.81	63.11	63.42	
	Average = Σ(39)1...12/12 =											62.96	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.99	0.98	0.98	0.97	0.97	0.96	0.96	0.96	0.96	0.97	0.97	0.98	
	Average = Σ(40)1...12/12 =											0.97	(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												2.12	(42)	
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36												84.46	(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)														
	92.91	89.53	86.15	82.77	79.39	76.02	76.02	79.39	82.77	86.15	89.53	92.91		
												Σ(44)1...12 =	1013.53	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)														
	137.78	120.50	124.35	108.41	104.02	89.76	83.18	95.45	96.59	112.56	122.87	133.43		
												Σ(45)1...12 =	1328.90	(45)
Distribution loss 0.15 x (45)m														
	20.67	18.08	18.65	16.26	15.60	13.46	12.48	14.32	14.49	16.88	18.43	20.01	(46)	
Water storage loss calculated for each month (55) x (41)m														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)	
Primary circuit loss for each month from Table 3														
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)	
Combi loss for each month from Table 3a, 3b or 3c														
	47.34	41.21	43.90	40.82	40.46	37.49	38.74	40.46	40.82	43.90	44.15	47.34	(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m														
	185.12	161.71	168.25	149.23	144.48	127.25	121.91	135.91	137.41	156.47	167.02	180.78	(62)	
Solar DHW input calculated using Appendix G or Appendix H														

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
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Output from water heater for each month (kWh/month) (62)m + (63)m

185.12	161.71	168.25	149.23	144.48	127.25	121.91	135.91	137.41	156.47	167.02	180.78	
Σ(64)1...12 =											1835.53	(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]

57.65	50.37	52.32	46.25	44.70	39.22	37.34	41.85	42.32	48.40	51.89	56.20	(65)
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5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	16.52	14.67	11.93	9.03	6.75	5.70	6.16	8.01	10.75	13.64	15.92	16.98	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	185.11	187.04	182.19	171.89	158.88	146.66	138.49	136.57	141.41	151.71	164.72	176.95	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	(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)	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	(71)
Water heating gains (Table 5)	77.48	74.95	70.32	64.24	60.08	54.47	50.19	56.25	58.78	65.06	72.07	75.54	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	336.86	334.40	322.19	302.90	283.46	264.57	252.58	258.57	268.67	288.16	310.46	327.21	(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	12.04	x	36.79	x 0.9 x	0.63	x	0.70	=	135.39	(77)	
East	0.77	x	2.05	x	19.64	x 0.9 x	0.63	x	0.70	=	12.30	(76)	
Solar gains in watts Σ(74)m...(82)m													
	147.69	254.68	355.17	448.78	508.76	507.27	488.19	443.43	387.76	283.44	177.50	125.98	(83)
Total gains - internal and solar (73)m + (83)m													
	484.55	589.09	677.37	751.68	792.22	771.84	740.77	702.00	656.44	571.60	487.97	453.19	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)												21.00	(85)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Utilisation factor for gains for living area n1,m (see Table 9a)													
0.99	0.98	0.95	0.86	0.70	0.51	0.37	0.41	0.64	0.90	0.98	1.00	(86)	
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													
20.12	20.33	20.58	20.83	20.95	20.99	21.00	21.00	20.98	20.79	20.41	20.08	(87)	
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)													
20.09	20.10	20.10	20.11	20.11	20.12	20.12	20.12	20.12	20.11	20.11	20.10	(88)	
Utilisation factor for gains for rest of dwelling n2,m													
0.99	0.98	0.93	0.82	0.64	0.44	0.29	0.33	0.56	0.87	0.98	0.99	(89)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													

	18.93	19.23	19.59	19.92	20.07	20.12	20.12	20.12	20.10	19.89	19.35	18.88	(90)	
Living area fraction	Living area ÷ (4) =												0.39	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2														
	19.40	19.66	19.97	20.27	20.42	20.46	20.46	20.44	20.24	19.76	19.35		(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate														
	19.40	19.66	19.97	20.27	20.42	20.46	20.46	20.44	20.24	19.76	19.35		(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	0.93	0.83	0.66	0.47	0.32	0.36	0.59	0.88	0.98	0.99	(94)	
Useful gains, ηmGm, W (94)m x (84)m														
	479.77	573.31	631.09	624.53	525.72	361.55	239.72	251.50	387.26	500.80	476.49	449.96	(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]														
	967.40	943.20	858.83	716.01	547.44	363.95	239.95	251.90	395.82	605.76	799.28	960.78	(97)	
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m														
	362.80	248.57	169.44	65.87	16.16	0.00	0.00	0.00	0.00	78.09	232.41	380.06		
	Σ(98)1...5, 10...12 =												1553.39	(98)
Space heating requirement kWh/m²/year	(98) ÷ (4) =												23.94	(99)
9a. Energy requirements - individual heating systems including micro-CHP														
Space heating														
Fraction of space heat from secondary/supplementary system (table 11)												0.00	(201)	
Fraction of space heat from main system(s)												1 - (201) =	1.00	(202)
Fraction of space heat from main system 2												0.00	(202)	
Fraction of total space heat from main system 1												(202) x [1- (203)] =	1.00	(204)
Fraction of total space heat from main system 2												(202) x (203) =	0.00	(205)
Efficiency of main system 1 (%)												93.40	(206)	
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Space heating fuel (main system 1), kWh/month														
	388.44	266.14	181.41	70.52	17.30	0.00	0.00	0.00	0.00	83.60	248.84	406.91		
	Σ(211)1...5, 10...12 =												1663.16	(211)
Water heating														
Efficiency of water heater														
	86.71	86.13	85.07	83.14	81.21	80.30	80.30	80.30	80.30	83.40	85.88	86.88	(217)	
Water heating fuel, kWh/month														
	213.48	187.75	197.78	179.48	177.90	158.47	151.82	169.25	171.12	187.60	194.48	208.08		
	Σ(219a)1...12 =												2197.22	(219)
Annual totals														
Space heating fuel - main system 1												1663.16		
Water heating fuel												2197.22		
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)												291.70	(232)	

Total delivered energy for all uses (211)...(221) + (231) + (232)...(237b) = 4227.07 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1663.16	x	3.48	x 0.01 =	57.88	(240)
Water heating	2197.22	x	3.48	x 0.01 =	76.46	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	291.70	x	13.19	x 0.01 =	38.47	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		302.71	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.16	(257)
SAP value	83.86	
SAP rating (section 13)	84	(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	1663.16	x	0.216	=	359.24	(261)
Water heating	2197.22	x	0.216	=	474.60	(264)
Space and water heating			(261) + (262) + (263) + (264) =		833.84	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	291.70	x	0.519	=	151.39	(268)
Total CO ₂ , kg/year			(265)...(271) =		1024.16	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		15.78	(273)
El value					87.51	
El rating (section 14)					88	(274)
El 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	1663.16	x	1.22	=	2029.06	(261)
Water heating	2197.22	x	1.22	=	2680.60	(264)
Space and water heating			(261) + (262) + (263) + (264) =		4709.66	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	291.70	x	3.07	=	895.51	(268)
Primary energy kWh/year					5835.42	(272)
Dwelling primary energy rate kWh/m2/year					89.91	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	22/09/2020
Address	2BA11 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	73.25 (1a) x	2.50 (2a) =	183.13 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 73.25 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	183.13 (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) = 0.16 (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)	0.41 (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) = 0.35 (21)
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Infiltration rate modified for monthly wind speed:

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

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.93	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	0.45	0.44	0.43	0.39	0.38	0.33	0.33	0.35	0.38	0.40	0.41
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Calculate effective air change rate for the applicable case:

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

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

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

0.60	0.60	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.60	0.60	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59
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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	2.12	x	1.00	=	2.12		(26)
Window	15.84	x	1.33	=	21.00		(27)
Exposed floor	73.25	x	0.13	=	9.52		(28b)
External wall	40.34	x	0.18	=	7.26		(29a)
Party wall	48.44	x	0.00	=	0.00		(32)
Total area of external elements ΣA, m ²	131.55						(31)
Fabric heat loss, W/K = Σ(A x U)						(26)...(30) + (32) =	39.90 (33)
Heat capacity Cm = Σ(A x k)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m ² K							250.00 (35)
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							12.50 (36)
Total fabric heat loss						(33) + (36) =	52.40 (37)

Ventilation heat loss calculated monthly 0.33 x (25)m x (5)												
36.29	36.06	35.83	34.74	34.54	33.59	33.59	33.41	33.95	34.54	34.95	35.38	(38)
Heat transfer coefficient, W/K (37)m + (38)m												
88.70	88.46	88.23	87.14	86.94	85.99	85.99	85.82	86.36	86.94	87.35	87.78	
Average = $\sum(39)1...12/12 =$											87.14	(39)

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.21	1.21	1.20	1.19	1.19	1.17	1.17	1.18	1.19	1.19	1.20
Average = Σ(40)1...12/12 =	1.19 (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	2.32 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	89.36 (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)	98.29	94.72	91.14	87.57	83.99	80.42	83.99	87.57	91.14	94.72	98.29
Σ(44)1...12 =	1072.28 (44)										

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)													
145.76	127.49	131.55	114.69	110.05	94.96	88.00	100.98	102.19	119.09	129.99	141.16		
											Σ(45)1...12 =	1405.92	(45)

Distribution loss 0.15 x (45)m	21.86	19.12	19.73	17.20	16.51	14.24	13.20	15.15	15.33	17.86	19.50	21.17
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Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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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
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Combi loss for each month from Table 3a, 3b or 3c	50.09	43.60	46.45	43.18	42.80	39.66	40.98	42.80	43.18	46.45	46.71	50.09
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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	195.85	171.08	178.00	157.88	152.85	134.62	128.98	143.78	145.37	165.53	176.70	191.25
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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
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Output from water heater for each month (kWh/month) (62)m + (63)m

195.85	171.08	178.00	157.88	152.85	134.62	128.98	143.78	145.37	165.53	176.70	191.25
$\Sigma(64)1...12 =$											1941.91

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

60.99	53.29	55.35	48.93	47.29	41.49	39.50	44.28	44.77	51.21	54.90	59.46
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5. Internal gains

Metabolic gains (Table 5)

116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12
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Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

18.27	16.23	13.20	9.99	7.47	6.31	6.81	8.86	11.89	15.09	17.62	18.78
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Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

204.76	206.89	201.53	190.13	175.74	162.22	153.19	151.06	156.41	167.81	182.20	195.73
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

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

34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61
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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
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Losses e.g. evaporation (Table 5)

-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89
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Water heating gains (Table 5)

81.97	79.30	74.40	67.96	63.57	57.63	53.10	59.51	62.18	68.83	76.25	79.92
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Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

365.84	363.25	349.97	328.92	307.61	286.99	273.93	280.26	291.32	312.57	336.91	355.26
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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
North	0.77	9.51	10.63	0.63	0.70	30.90
South	0.77	3.99	46.75	0.63	0.70	57.01
NorthEast	0.77	2.34	11.28	0.63	0.70	8.07

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

95.98	168.85	248.88	344.22	422.55	436.91	413.90	352.04	280.96	191.08	115.85	81.61
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Total gains - internal and solar (73)m + (83)m

461.83	532.10	598.85	673.14	730.16	723.90	687.83	632.30	572.28	503.65	452.76	436.88
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7. Mean internal temperature (heating season)

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

21.00

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

1.00	0.99	0.99	0.96	0.87	0.70	0.54	0.60	0.85	0.97	0.99	1.00
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

19.71	19.86	20.13	20.48	20.78	20.95	20.99	20.98	20.86	20.47	20.03	19.68
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

19.91	19.91	19.92	19.93	19.93	19.94	19.94	19.94	19.94	19.93	19.93	19.92
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Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.98	0.94	0.82	0.61	0.41	0.47	0.77	0.96	0.99	1.00
------	------	------	------	------	------	------	------	------	------	------	------

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

18.19	18.43	18.81	19.32	19.72	19.91	19.94	19.93	19.82	19.32	18.68	18.16
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Living area fraction

Living area ÷ (4) =

0.44

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

18.87	19.07	19.39	19.83	20.19	20.37	20.40	20.40	20.28	19.83	19.28	18.84
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

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

18.87	19.07	19.39	19.83	20.19	20.37	20.40	20.40	20.28	19.83	19.28	18.84
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

8. Space heating requirement

Utilisation factor for gains, ηm

1.00	0.99	0.98	0.94	0.83	0.65	0.47	0.53	0.80	0.96	0.99	1.00
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Useful gains, ηmGm, W (94)m x (84)m

459.74	527.19	585.87	631.66	609.62	469.06	322.72	335.41	458.54	483.23	448.71	435.35
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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
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Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m]

1291.98	1253.14	1137.61	952.69	737.96	496.00	327.12	343.23	533.99	802.68	1063.67	1284.89
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Space heating requirement, kWh/month $0.024 \times [(97)m - (95)m] \times (41)m$

619.18	487.84	410.50	231.14	95.49	0.00	0.00	0.00	0.00	237.67	442.77	632.06
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$\Sigma(98)1...5, 10...12 =$

3156.64

(98) ÷ (4)

43.09

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 (%)

93.40

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

662.93	522.31	439.51	247.47	102.23	0.00	0.00	0.00	0.00	254.47	474.06	676.72
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$\Sigma(211)1...5, 10...12 =$

3379.70

Water heating

Efficiency of water heater

87.75	87.54	87.09	86.01	83.90	80.30	80.30	80.30	80.30	85.96	87.27	87.83
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Water heating fuel, kWh/month

223.20	195.43	204.39	183.56	182.18	167.65	160.62	179.06	181.03	192.57	202.48	217.74
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$\Sigma(219a)1...12 =$

2289.92

Annual totals

Space heating fuel - main system 1

3379.70

Water heating fuel

2289.92

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

central heating pump or water pump within warm air heating unit

30.00

boiler flue fan

45.00

Total electricity for the above, kWh/year				75.00	(231)
Electricity for lighting (Appendix L)				322.71	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =			6067.33	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	3379.70	x	3.48	x 0.01 =	117.61	(240)
Water heating	2289.92	x	3.48	x 0.01 =	79.69	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	322.71	x	13.19	x 0.01 =	42.57	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		369.76	(255)

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

Energy cost deflator (Table 12)				0.42	(256)
Energy cost factor (ECF)				1.31	(257)
SAP value				81.68	
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	3379.70	x	0.216	=	730.02	(261)
Water heating	2289.92	x	0.216	=	494.62	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1224.64	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	322.71	x	0.519	=	167.49	(268)
Total CO ₂ , kg/year			(265)...(271) =		1431.05	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		19.54	(273)
EI value					83.78	
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	3379.70	x	1.22	=	4123.24	(261)
Water heating	2289.92	x	1.22	=	2793.70	(264)
Space and water heating			(261) + (262) + (263) + (264) =		6916.94	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	322.71	x	3.07	=	990.72	(268)
Primary energy kWh/year					8137.91	(272)
Dwelling primary energy rate kWh/m ² /year					111.10	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	22/09/2020
Address	2BA11 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)	
Lowest occupied	73.25	(1a) x	2.50	(2a) =	183.13	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) =	73.25	(4)			
Dwelling volume			(3a) + (3b) + (3c) + (3d)...(3n) =		183.13	(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) =	0.16	(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)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)				0.41	(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) =	0.35	(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	0.45	0.44	0.43	0.39	0.38	0.33	0.33	0.33	0.35	0.38	0.40	0.41	(22b)
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Calculate effective air change rate for the applicable case:

If mechanical ventilation: air change rate through system													N/A	(23a)
If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h													N/A	(23c)
d) natural ventilation or whole house positive input ventilation from loft	0.60	0.60	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(24d)	

Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.60	0.60	0.59	0.57	0.57	0.56	0.56	0.55	0.56	0.57	0.58	0.59	(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			2.12	x	1.00	=	2.12	(26)					
Window			15.84	x	1.33	=	21.00	(27)					
External wall			40.34	x	0.18	=	7.26	(29a)					
Party wall			48.44	x	0.00	=	0.00	(32)					
Total area of external elements ΣA, m ²			58.30					(31)					
Fabric heat loss, W/K = Σ(A × U)						(26)...(30) + (32) =	30.38	(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							5.11	(36)					
Total fabric heat loss						(33) + (36) =	35.49	(37)					
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	36.29	36.06	35.83	34.74	34.54	33.59	33.59	33.41	33.95	34.54	34.95	35.38	(38)
Heat transfer coefficient, W/K (37)m + (38)m	71.78	71.55	71.32	70.23	70.03	69.08	69.08	68.90	69.44	70.03	70.44	70.87	
	Average = Σ(39)1...12/12 =											70.23	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.98	0.98	0.97	0.96	0.96	0.94	0.94	0.94	0.95	0.96	0.96	0.97	
	Average = Σ(40)1...12/12 =											0.96	(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												2.32	(42)	
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36												89.36	(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)	98.29	94.72	91.14	87.57	83.99	80.42	80.42	83.99	87.57	91.14	94.72	98.29		
												Σ(44)1...12 =	1072.28	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	145.76	127.49	131.55	114.69	110.05	94.96	88.00	100.98	102.19	119.09	129.99	141.16		
												Σ(45)1...12 =	1405.92	(45)
Distribution loss 0.15 x (45)m	21.86	19.12	19.73	17.20	16.51	14.24	13.20	15.15	15.33	17.86	19.50	21.17	(46)	
Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(57)	
Primary circuit loss for each month from Table 3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(59)	
Combi loss for each month from Table 3a, 3b or 3c	50.09	43.60	46.45	43.18	42.80	39.66	40.98	42.80	43.18	46.45	46.71	50.09	(61)	
Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m	195.85	171.08	178.00	157.88	152.85	134.62	128.98	143.78	145.37	165.53	176.70	191.25	(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													
195.85	171.08	178.00	157.88	152.85	134.62	128.98	143.78	145.37	165.53	176.70	191.25		
											Σ(64)1...12 =	1941.91	(64)
Heat gains from water heating (kWh/month) $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$													
60.99	53.29	55.35	48.93	47.29	41.49	39.50	44.28	44.77	51.21	54.90	59.46	(65)	
5. Internal gains													
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Metabolic gains (Table 5)													
116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	(66)	
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
18.27	16.23	13.20	9.99	7.47	6.31	6.81	8.86	11.89	15.09	17.62	18.78	(67)	
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
204.76	206.89	201.53	190.13	175.74	162.22	153.19	151.06	156.41	167.81	182.20	195.73	(68)	
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	(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)													
-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	(71)	
Water heating gains (Table 5)													
81.97	79.30	74.40	67.96	63.57	57.63	53.10	59.51	62.18	68.83	76.25	79.92	(72)	
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
365.84	363.25	349.97	328.92	307.61	286.99	273.93	280.26	291.32	312.57	336.91	355.26	(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		
North	0.77	x	9.51	x	10.63	x 0.9 x	0.63	x	0.70	=	30.90	(74)	
South	0.77	x	3.99	x	46.75	x 0.9 x	0.63	x	0.70	=	57.01	(78)	
NorthEast	0.77	x	2.34	x	11.28	x 0.9 x	0.63	x	0.70	=	8.07	(75)	
Solar gains in watts Σ(74)m...(82)m													
	95.98	168.85	248.88	344.22	422.55	436.91	413.90	352.04	280.96	191.08	115.85	81.61	(83)
Total gains - internal and solar (73)m + (83)m													
	461.83	532.10	598.85	673.14	730.16	723.90	687.83	632.30	572.28	503.65	452.76	436.88	(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	0.93	0.80	0.60	0.44	0.50	0.77	0.96	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	20.02	20.17	20.41	20.71	20.91	20.99	21.00	21.00	20.95	20.68	20.30	20.00	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)													
	20.10	20.10	20.11	20.12	20.12	20.13	20.13	20.13	20.13	20.12	20.12	20.11	(88)
Utilisation factor for gains for rest of dwelling n2,m													
	1.00	0.99	0.98	0.91	0.75	0.52	0.35	0.41	0.70	0.94	0.99	1.00	(89)

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

18.79	19.02	19.36	19.78	20.04	20.12	20.13	20.13	20.09	19.75	19.21	18.77	(90)
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Living area fraction

Living area ÷ (4) =

0.44

(91)

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

19.34	19.53	19.82	20.19	20.43	20.51	20.52	20.52	20.47	20.16	19.69	19.31	(92)
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Apply adjustment to the mean internal temperature from Table 4e where appropriate

19.34	19.53	19.82	20.19	20.43	20.51	20.52	20.52	20.47	20.16	19.69	19.31	(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	0.97	0.91	0.77	0.56	0.39	0.45	0.73	0.95	0.99	1.00	(94)	
Useful gains, ηmGm, W (94)m x (84)m													
459.77	526.66	582.59	614.99	561.05	401.91	269.85	282.24	415.76	476.06	448.27	435.43	(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]													
1079.63	1046.82	950.19	792.92	611.05	408.04	270.51	283.60	442.35	669.46	886.86	1071.11	(97)	
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
461.17	349.55	273.49	128.11	37.19	0.00	0.00	0.00	0.00	143.89	315.79	472.95		
											Σ(98)1...5, 10...12 =	2182.14	(98)
											(98) ÷ (4)	29.79	(99)
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Space heating fuel (main system 1), kWh/month													
493.76	374.25	292.82	137.17	39.82	0.00	0.00	0.00	0.00	154.05	338.10	506.37		
											Σ(211)1...5, 10...12 =	2336.33	(211)
87.13	86.81	86.13	84.53	82.10	80.30	80.30	80.30	80.30	84.70	86.50	87.24	(217)	
224.77	197.07	206.67	186.77	186.19	167.65	160.62	179.06	181.03	195.43	204.29	219.23		

Electricity for lighting (Appendix L)

322.71

(232)

Total delivered energy for all uses

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

5042.83

(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2336.33	x	3.48	x 0.01 =	81.30	(240)
Water heating	2308.79	x	3.48	x 0.01 =	80.35	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	322.71	x	13.19	x 0.01 =	42.57	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		334.11	(255)
	Energy kWh/year		Emission factor kg CO ₂ /kWh		Emissions kg CO ₂ /year	
Space heating - main system 1	2336.33	x	0.216	=	504.65	(261)
Water heating	2308.79	x	0.216	=	498.70	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1003.35	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	322.71	x	0.519	=	167.49	(268)
Total CO ₂ , kg/year			(265)...(271) =		1209.76	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		16.52	(273)
El value					86.29	
El rating (section 14)					86	(274)
El band					B	
	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	2336.33	x	1.22	=	2850.33	(261)
Water heating	2308.79	x	1.22	=	2816.72	(264)
Space and water heating			(261) + (262) + (263) + (264) =		5667.05	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	322.71	x	3.07	=	990.72	(268)
Primary energy kWh/year					6888.02	(272)
Dwelling primary energy rate kWh/m2/year					94.03	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	22/09/2020
Address	3BA1 TF Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	75.25 (1a) x	2.50 (2a) =	188.13 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 75.25 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	188.13 (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)

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 30 ÷ (5) =	0.16 (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, 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)	0.41 (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) = 0.35 (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	5.10	5.00	4.90	4.40	4.30	3.80	3.80	3.70	4.00	4.30	4.50	4.70
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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	0.44	0.44	0.43	0.38	0.37	0.33	0.33	0.32	0.37	0.39	0.41
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Calculate effective air change rate for the applicable case:	0.44	0.44	0.43	0.38	0.37	0.33	0.33	0.32	0.37	0.39	0.41
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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	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58
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3. Heat losses and heat loss parameter

Element	Gross area, m ²	Openings m ²	Net area A, m ²	U-value W/m ² K	A x U W/K	k-value, kJ/m ² .K	A x k, kJ/K
Door			2.12	x 1.00	= 2.12		(26)
Window			12.75	x 1.33	= 16.90		(27)
External wall			47.91	x 0.18	= 8.62		(29a)
Party wall			55.08	x 0.00	= 0.00		(32)
Roof			75.25	x 0.13	= 9.78		(30)
Total area of external elements ΣA, m ²			138.03				(31)

Fabric heat loss, W/K = Σ(A x U)	(26)...(30) + (32) =	37.43 (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	250.00 (35)
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Thermal bridges: Σ(L x Ψ) calculated using Appendix K	21.79 (36)
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Total fabric heat loss	(33) + (36) =	59.22 (37)
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
37.15	36.92	36.68	35.59	35.39	34.43	34.43	34.26	34.80	35.39	35.80	36.23

Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	37.15	36.92	36.68	35.59	35.39	34.43	34.43	34.26	34.80	35.39	35.80	36.23
Heat transfer coefficient, W/K (37)m + (38)m	96.37	96.14	95.90	94.81	94.61	93.66	93.66	93.48	94.02	94.61	95.02	95.45
Average = Σ(39)1...12/12 =	94.81 (39)											

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.28	1.28	1.27	1.26	1.26	1.24	1.24	1.24	1.25	1.26	1.26	1.27
Average = Σ(40)1...12/12 =	1.26 (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	2.37 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	90.41 (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99.45	95.83	92.21	88.60	84.98	81.37	81.37	84.98	88.60	92.21	95.83	99.45
Σ(44)1...12 = 1084.87 (44)											

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	147.48	128.98	133.10	116.04	111.34	96.08	89.03	102.17	103.39	120.49	131.52	142.82
Σ(45)1...12 =	1422.44 (45)											

Distribution loss 0.15 x (45)m	22.12	19.35	19.96	17.41	16.70	14.41	13.35	15.32	15.51	18.07	19.73	21.42
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Water storage loss calculated for each month (55) x (41)m	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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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
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Combi loss for each month from Table 3a, 3b or 3c	50.68	44.11	46.99	43.69	43.31	40.13	41.46	43.31	43.69	46.99	47.26	50.68
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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	198.15	173.09	180.09	159.73	154.65	136.21	130.50	145.47	147.08	167.48	178.78	193.50
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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
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 (63)

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

198.15	173.09	180.09	159.73	154.65	136.21	130.50	145.47	147.08	167.48	178.78	193.50
$\Sigma(64)1...12 =$											1964.72

 (64)

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

61.71	53.91	56.00	49.51	47.85	41.98	39.97	44.80	45.30	51.81	55.55	60.16
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 (65)

5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains (Table 5)											
118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33

 (66)

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

19.25	17.10	13.90	10.53	7.87	6.64	7.18	9.33	12.52	15.90	18.56	19.78
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 (67)

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

209.23	211.40	205.93	194.28	179.58	165.76	156.53	154.36	159.83	171.47	186.18	200.00
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 (68)

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

34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83
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 (69)

Pump and fan gains (Table 5a)

3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
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 (70)

Losses e.g. evaporation (Table 5)

-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66
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 (71)

Water heating gains (Table 5)

82.94	80.23	75.27	68.76	64.31	58.30	53.72	60.21	62.92	69.64	77.15	80.86
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 (72)

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

372.91	370.22	356.60	335.06	313.26	292.20	278.93	285.40	296.76	318.51	343.38	362.14
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 (73)

6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W
North	0.77	8.07	10.63	0.9	0.63	26.23
South	0.77	4.68	46.75	0.9	0.63	66.87

 (74) (75)

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

93.09	159.63	224.66	294.46	348.57	355.38	338.66	296.15	248.12	177.78	111.61	79.64
-------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	-------

 (83)

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

466.01	529.85	581.27	629.52	661.82	647.58	617.59	581.54	544.88	496.29	454.99	441.78
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 (84)

7. Mean internal temperature (heating season)

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

21.00

 (85)

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

1.00	1.00	0.99	0.97	0.92	0.79	0.63	0.68	0.89	0.98	1.00	1.00
------	------	------	------	------	------	------	------	------	------	------	------

 (86)

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

19.60	19.76	20.00	20.34	20.67	20.89	20.97	20.96	20.80	20.39	19.94	19.58
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (87)

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

19.86	19.86	19.86	19.87	19.87	19.88	19.88	19.89	19.88	19.87	19.87	19.87
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.99	0.96	0.88	0.70	0.49	0.54	0.82	0.97	0.99	1.00
------	------	------	------	------	------	------	------	------	------	------	------

 (89)

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

18.01	18.23	18.59	19.09	19.53	19.81	19.87	19.87	19.71	19.16	18.51	17.98
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (90)

Living area fraction

Living area ÷ (4) =	0.36
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 (91)

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

18.58	18.78	19.10	19.54	19.94	20.20	20.27	20.26	20.10	19.60	19.02	18.55
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (92)

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

18.58	18.78	19.10	19.54	19.94	20.20	20.27	20.26	20.10	19.60	19.02	18.55
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (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	0.98	0.96	0.88	0.73	0.54	0.59	0.84	0.97	0.99	1.00

 (94)

Useful gains, ηmGm, W (94)m x (84)m

463.92	525.36	570.93	601.48	585.14	471.74	333.56	345.46	457.01	478.97	451.11	440.23
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (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]

1376.25	1334.03	1208.38	1008.80	779.54	524.26	343.47	360.80	564.14	851.73	1132.59	1369.94
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 (97)

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

678.78	543.43	474.26	293.27	144.63	0.00	0.00	0.00	277.33	490.66	691.71
$\Sigma(98)1...5, 10...12 =$										3594.07
$(98) \div (4) =$										47.76

 (98) (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
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 (%)	93.40

 (201) (202) (202) (204) (205) (206)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month											
726.74	581.83	507.77	314.00	154.86	0.00	0.00	0.00	0.00	296.93	525.33	740.59
$\Sigma(211)_{1...5, 10...12} =$										3848.04	(211)

Water heating

Efficiency of water heater

87.90	87.73	87.38	86.56	84.88	80.30	80.30	80.30	80.30	86.31	87.46	87.98
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 (217)

Water heating fuel, kWh/month

225.43	197.29	206.11	184.53	182.19	169.62	162.51	181.16	183.16	194.04	204.41	219.93
$\Sigma(219a)1...12 =$										2310.38	(219)

Annual totals

Space heating fuel - main system 1	3848.04
Water heating fuel	2310.38
Electricity for pumps, fans and electric keep-hot (Table 4f)	
central heating pump or water pump within warm air heating unit	30.00
boiler flue fan	45.00
Total electricity for the above, kWh/year	75.00

 (230c) (230e) (231)

	339.95	(232)
(211)...(221) + (231) + (232)...(237b) =	6573.37	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	3848.04	x	3.48	x 0.01 =	133.91	(240)
Water heating	2310.38	x	3.48	x 0.01 =	80.40	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	339.95	x	13.19	x 0.01 =	44.84	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		389.05	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.36	(257)
SAP value	81.04	
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	3848.04	x	0.216	=	831.18	(261)
Water heating	2310.38	x	0.216	=	499.04	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1330.22	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	339.95	x	0.519	=	176.44	(268)
Total CO ₂ , kg/year			(265)...(271) =		1545.58	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		20.54	(273)
EI value					82.78	
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	3848.04	x	1.22	=	4694.61	(261)
Water heating	2310.38	x	1.22	=	2818.66	(264)
Space and water heating			(261) + (262) + (263) + (264) =		7513.27	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	339.95	x	3.07	=	1043.65	(268)
Primary energy kWh/year					8787.18	(272)
Dwelling primary energy rate kWh/m ² /year					116.77	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	22/09/2020
Address	3BA2 TF Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)	
Lowest occupied	75.50	(1a) x	2.50	(2a) =	188.75	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 75.50	(4)				
Dwelling volume			(3a) + (3b) + (3c) + (3d)...(3n) =		188.75	(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	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) =	0.16	(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			5.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)			0.41	(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) =	0.35	(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

0.44	0.43	0.43	0.38	0.37	0.33	0.33	0.32	0.35	0.37	0.39	0.41	(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

0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58	(24d)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.60	0.59	0.59	0.57	0.57	0.55	0.55	0.55	0.56	0.57	0.58	0.58	(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			2.12	x 1.00	= 2.12			(26)					
Window			10.41	x 1.33	= 13.80			(27)					
External wall			96.69	x 0.18	= 17.40			(29a)					
Party wall			11.48	x 0.00	= 0.00			(32)					
Roof			75.50	x 0.13	= 9.82			(30)					
Total area of external elements ΣA, m ²			184.72					(31)					
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	43.14		(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						25.55		(36)					
Total fabric heat loss					(33) + (36) =	68.69		(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)	37.26	37.02	36.79	35.70	35.49	34.54	34.54	34.36	34.91	35.49	35.91	36.34	(38)
Heat transfer coefficient, W/K (37)m + (38)m	105.95	105.72	105.48	104.39	104.19	103.23	103.23	103.06	103.60	104.19	104.60	105.03	
	Average = Σ(39)1...12/12 =											104.39	(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.40	1.40	1.40	1.38	1.38	1.37	1.37	1.36	1.37	1.38	1.39	1.39	
	Average = Σ(40)1...12/12 =											1.38	(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

2.37

(42)

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

90.53

(43)

JanFebMarAprMayJunJulAugSepOctNovDec

Hot water usage in litres per day for each month $V_{d,m}$ = factor from Table 1c x (43)

99.5995.9792.3488.7285.1081.4881.4885.1088.7292.3495.9799.59

$\sum(44)1...12 =$

1086.40

(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)

147.68129.17133.29116.20111.5096.2289.16102.31103.53120.66131.71143.02

$\sum(45)1...12 =$

1424.45

(45)

Distribution loss $0.15 \times (45)m$

22.1519.3719.9917.4316.7214.4313.3715.3515.5318.1019.7621.45

(46)

Water storage loss calculated for each month $(55) \times (41)m$

0.000.000.000.000.000.000.000.000.000.000.000.00

(56)

If the vessel contains dedicated solar storage or dedicated WWHRS $(56)m \times [(47) - V_s] \div (47)$, else (56)

0.000.000.000.000.000.000.000.000.000.000.000.00

(57)

Primary circuit loss for each month from Table 3

0.000.000.000.000.000.000.000.000.000.000.000.00

(59)

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

50.7544.1747.0643.7543.3740.1841.5243.3743.7547.0647.3350.75

(61)

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

198.43173.34180.35159.96154.87136.40130.68145.68147.29167.71179.03193.77

(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													
198.43	173.34	180.35	159.96	154.87	136.40	130.68	145.68	147.29	167.71	179.03	193.77		
											$\Sigma(64)1...12 =$	1967.50	(64)
Heat gains from water heating (kWh/month) $0.25 \times [0.85 \times (45)m + (61)m] + 0.8 \times [(46)m + (57)m + (59)m]$													
61.79	53.99	56.08	49.58	47.92	42.04	40.03	44.86	45.36	51.88	55.62	60.24	(65)	

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	20.13	17.88	14.54	11.01	8.23	6.95	7.51	9.76	13.10	16.63	19.41	20.69	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	209.78	211.96	206.47	194.79	180.05	166.20	156.94	154.76	160.25	171.93	186.67	200.52	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	(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)	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	(71)
Water heating gains (Table 5)	83.05	80.34	75.38	68.86	64.40	58.39	53.80	60.30	63.00	69.73	77.26	80.97	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	374.54	371.76	357.97	336.24	314.26	293.11	279.82	286.40	297.93	319.87	344.91	363.76	(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	
South	0.77	x	8.07	x	46.75	x 0.9 x	0.63	x	0.70	=	115.30	(78)
North	0.77	x	2.34	x	10.63	x 0.9 x	0.63	x	0.70	=	7.60	(74)
Solar gains in watts Σ(74)m...(82)m												
	122.91	203.37	265.24	311.54	336.74	329.84	319.79	301.07	280.97	220.98	146.06	105.97 (83)
Total gains - internal and solar (73)m + (83)m												
	497.45	575.13	623.21	647.77	651.00	622.95	599.62	587.47	578.90	540.85	490.97	469.74 (84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)	<table><tr><td>21.00</td></tr></table>												21.00	(85)												
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)	<table><tr><td>1.00</td><td>0.99</td><td>0.99</td><td>0.97</td><td>0.93</td><td>0.84</td><td>0.69</td><td>0.72</td><td>0.89</td><td>0.98</td><td>0.99</td><td>1.00</td></tr></table>													1.00	0.99	0.99	0.97	0.93	0.84	0.69	0.72	0.89	0.98	0.99	1.00	(86)
1.00	0.99	0.99	0.97	0.93	0.84	0.69	0.72	0.89	0.98	0.99	1.00															
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	<table><tr><td>19.49</td><td>19.66</td><td>19.91</td><td>20.24</td><td>20.57</td><td>20.83</td><td>20.95</td><td>20.94</td><td>20.76</td><td>20.34</td><td>19.85</td><td>19.46</td></tr></table>													19.49	19.66	19.91	20.24	20.57	20.83	20.95	20.94	20.76	20.34	19.85	19.46	(87)
19.49	19.66	19.91	20.24	20.57	20.83	20.95	20.94	20.76	20.34	19.85	19.46															
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	<table><tr><td>19.76</td><td>19.76</td><td>19.77</td><td>19.78</td><td>19.78</td><td>19.79</td><td>19.79</td><td>19.78</td><td>19.78</td><td>19.77</td><td>19.77</td></tr></table>												19.76	19.76	19.77	19.78	19.78	19.79	19.79	19.78	19.78	19.77	19.77	(88)		
19.76	19.76	19.77	19.78	19.78	19.79	19.79	19.78	19.78	19.77	19.77																
Utilisation factor for gains for rest of dwelling n2,m	<table><tr><td>1.00</td><td>0.99</td><td>0.98</td><td>0.96</td><td>0.90</td><td>0.75</td><td>0.53</td><td>0.57</td><td>0.82</td><td>0.96</td><td>0.99</td><td>1.00</td></tr></table>												1.00	0.99	0.98	0.96	0.90	0.75	0.53	0.57	0.82	0.96	0.99	1.00	(89)	
1.00	0.99	0.98	0.96	0.90	0.75	0.53	0.57	0.82	0.96	0.99	1.00															

Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
17.77	18.02	18.39	18.88	19.33	19.67	19.77	19.76	19.59	19.02	18.31	17.73	(90)	
Living area fraction										Living area ÷ (4) =		0.36	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2													
18.39	18.61	18.94	19.38	19.78	20.09	20.20	20.19	20.01	19.50	18.87	18.36	(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
18.39	18.61	18.94	19.38	19.78	20.09	20.20	20.19	20.01	19.50	18.87	18.36	(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	0.96	0.90	0.77	0.59	0.62	0.84	0.96	0.99	1.00	(94)
Useful gains, $\eta_m G_m$, W (94)m x (84)m													
	494.50	568.61	609.79	618.92	586.59	482.12	352.67	366.03	484.02	517.99	485.47	467.54	(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]													
	1493.22	1449.66	1312.72	1093.49	841.96	566.77	371.38	390.53	612.47	926.75	1230.87	1487.08	(97)
Space heating requirement, kWh/month $0.024 \times [(97)m - (95)m] \times (41)m$													
	743.05	592.07	522.98	341.69	190.00	0.00	0.00	0.00	0.00	304.12	536.69	758.54	
										$\sum(98)1...5, 10...12 =$		3989.13	(98)
Space heating requirement kWh/m ² /year										$(98) \div (4) =$		52.84	(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 (%)

93.40

(206)

Jan

Feb

Mar

Apr

May

Jun

Jul

Aug

Sep

Oct

Nov

Dec

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

795.55

633.91

559.94

365.83

203.42

0.00

0.00

0.00

0.00

325.61

574.61

812.14

Σ(211)1...5, 10...12 =

4271.01

(211)

Water heating

Efficiency of water heater

88.07

87.90

87.58

86.91

85.57

80.30

80.30

80.30

80.30

86.53

87.64

88.14

(217)

Water heating fuel, kWh/month

225.32

197.21

205.93

184.04

180.99

169.86

162.74

181.42

183.42

193.82

204.28

219.84

Σ(219a)1...12 =

2308.86

(219)

Annual totals

Space heating fuel - main system 1

4271.01

Water heating fuel

2308.86

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	4271.01	x	3.48	x 0.01 =	148.63	(240)
Water heating	2308.86	x	3.48	x 0.01 =	80.35	(247)
Pumps and fans	75.00	x	13.19	x 0.01 =	9.89	(249)
Electricity for lighting	355.51	x	13.19	x 0.01 =	46.89	(250)
Additional standing charges					120.00	(251)
Total energy cost			(240)...(242) + (245)...(254) =		405.76	(255)

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

Energy cost deflator (Table 12)				0.42	(256)
Energy cost factor (ECF)				1.41	(257)
SAP value				80.27	
SAP rating (section 13)				80	(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	4271.01	x	0.216	=	922.54	(261)
Water heating	2308.86	x	0.216	=	498.71	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1421.25	(265)
Pumps and fans	75.00	x	0.519	=	38.93	(267)
Electricity for lighting	355.51	x	0.519	=	184.51	(268)
Total CO ₂ , kg/year				(265)...(271) =	1644.69	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	21.78	(273)
El value					81.71	
El rating (section 14)					82	(274)
El 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	4271.01	x	1.22	=	5210.64	(261)
Water heating	2308.86	x	1.22	=	2816.80	(264)
Space and water heating			(261) + (262) + (263) + (264) =		8027.44	(265)
Pumps and fans	75.00	x	3.07	=	230.25	(267)
Electricity for lighting	355.51	x	3.07	=	1091.43	(268)
Primary energy kWh/year					9349.12	(272)
Dwelling primary energy rate kWh/m2/year					123.83	(273)

Appendix D

DER Worksheets – *Be Lean*

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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	23/09/2020
Address	1BA2 GF Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	54.20 (1a) x	2.50 (2a) =	135.50 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 54.20 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	135.50 (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)

Infiltration due to chimneys, flues, fans, PSVs	(6a) + (6b) + (7a) + (7b) + (7c) = 0	÷ (5) =	0.00 (8)
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If a pressurisation test has been carried out or is intended, proceed to (17), otherwise continue from (9) to (16)

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	3.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.15 (18)
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Number of sides on which the dwelling is sheltered	2 (19)
--	--------

Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.13 (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 (22a)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.13	0.14	0.14	0.15 (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	73.10 (23c)
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a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.30	0.29	0.29	0.27	0.27	0.26	0.26	0.25	0.26	0.27	0.28 (24a)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.30	0.29	0.29	0.27	0.27	0.26	0.26	0.25	0.26	0.27	0.28 (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			2.12	x 1.00 =	2.12		(26)
Window			12.08	x 1.15 =	13.83		(27)
Ground floor			54.20	x 0.15 =	8.13		(28a)
External wall			46.82	x 0.18 =	8.43		(29a)
Party wall			19.44	x 0.00 =	0.00		(32)
Total area of external elements ΣA, m ²			115.22				(31)

Fabric heat loss, W/K = Σ(A x U)	(26)...(30) + (32) =	32.51 (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		250.00 (35)
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Thermal bridges: Σ(L x Ψ) calculated using Appendix K		11.41 (36)
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Total fabric heat loss	(33) + (36) =	43.92 (37)
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Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
13.28	13.14	13.00	12.29	12.14	11.43	11.43	11.29	11.72	12.14	12.43	12.71 (38)

Heat transfer coefficient, W/K (37)m + (38)m												
57.20	57.06	56.92	56.20	56.06	55.35	55.35	55.21	55.63	56.06	56.35	56.63	
Average = $\sum(39)1...12/12 =$												56.17 (39)

Heat loss parameter (HLP), W/m²K (39)m ÷ (4)												
1.06	1.05	1.05	1.04	1.03	1.02	1.02	1.02	1.03	1.03	1.04	1.04	
Average = $\sum(40)1...12/12 =$												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)
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4. Water heating energy requirement

Assumed occupancy, N	1.81 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	77.28 (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
85.01	81.92	78.83	75.73	72.64	69.55	69.55	72.64	75.73	78.83	81.92	85.01
Σ(44)1...12 =											927.36 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)													
126.06	110.26	113.77	99.19	95.18	82.13	76.11	87.33	88.38	102.99	112.42	122.09		
											Σ(45)1...12 =	1215.91	(45)

Distribution loss 0.15 x (45)m	18.91	16.54	17.07	14.88	14.28	12.32	11.42	13.10	13.26	15.45	16.86	18.31 (46)
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Storage volume (litres) including any solar or WWHRS storage within same vessel	180.00 (47)										
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Water storage loss:												
a) If manufacturer's declared loss factor is known (kWh/day)	1.95 (48)											
Temperature factor from Table 2b	0.60 (49)											
Energy lost from water storage (kWh/day) (48) x (49)	1.17 (50)											
Enter (50) or (54) in (55)	1.17 (55)											

Water storage loss calculated for each month (55) x (41)m	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27 (56)
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27 (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	0.00
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 (59)

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

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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 (61)

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

162.33	143.02	150.04	134.29	131.45	117.23	112.38	123.60	123.48	139.26	147.52	158.36
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 (62)

Solar DHW input calculated using Appendix G or Appendix H

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

 (63)

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

162.33	143.02	150.04	134.29	131.45	117.23	112.38	123.60	123.48	139.26	147.52	158.36
$\Sigma(64)1...12 =$											1642.96

 (64)

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

70.93	62.87	66.85	61.06	60.66	55.39	54.32	58.05	57.46	63.26	65.46	69.61
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 (65)

5. Internal gains

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains (Table 5)											
90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69	90.69

 (66)

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

14.10	12.52	10.18	7.71	5.76	4.86	5.26	6.83	9.17	11.64	13.59	14.49
-------	-------	-------	------	------	------	------	------	------	-------	-------	-------

 (67)

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

158.12	159.76	155.63	146.83	135.71	125.27	118.29	116.65	120.79	129.59	140.70	151.14
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (68)

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

32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07	32.07
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (69)

Pump and fan gains (Table 5a)

3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
------	------	------	------	------	------	------	------	------	------	------	------

 (70)

Losses e.g. evaporation (Table 5)

-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56	-72.56
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (71)

Water heating gains (Table 5)

95.34	93.55	89.85	84.81	81.54	76.93	73.01	78.03	79.81	85.03	90.92	93.56
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (72)

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

320.77	319.05	308.87	292.55	276.22	260.27	249.77	254.72	262.98	279.47	298.42	312.40
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (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	12.08	x	36.79	x 0.9 x	0.72	x	0.70	=	155.24 (77)

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

155.24	264.43	361.81	448.30	502.13	498.50	480.61	440.44	391.76	292.25	185.94	132.85
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 (83)

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

476.01	583.48	670.67	740.85	778.35	758.77	730.38	695.17	654.74	571.73	484.36	445.26
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 (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
-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----

 (85)

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

0.99	0.97	0.92	0.81	0.64	0.46	0.33	0.36	0.57	0.85	0.97	0.99
------	------	------	------	------	------	------	------	------	------	------	------

 (86)

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

20.15	20.37	20.63	20.85	20.96	21.00	21.00	21.00	20.98	20.83	20.45	20.10
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (87)

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

20.04	20.04	20.04	20.05	20.05	20.07	20.07	20.07	20.06	20.05	20.05	20.05
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (88)

Utilisation factor for gains for rest of dwelling n2,m

0.98	0.96	0.90	0.77	0.59	0.40	0.26	0.29	0.50	0.81	0.96	0.99
------	------	------	------	------	------	------	------	------	------	------	------

 (89)

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

18.92	19.25	19.60	19.90	20.02	20.06	20.07	20.07	20.05	19.88	19.37	18.86
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (90)

Living area fraction

Living area ÷ (4) =

0.44

 (91)

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

19.46	19.74	20.05	20.32	20.43	20.47	20.47	20.47	20.46	20.30	19.84	19.40
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (92)

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

19.31	19.59	19.90	20.17	20.28	20.32	20.32	20.32	20.31	20.15	19.69	19.25
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (93)

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation factor for gains, ηm											
0.98	0.95	0.89	0.77	0.60	0.42	0.28	0.31	0.52	0.82	0.96	0.99

 (94)

Useful gains, ηmGm, W (94)m x (84)m

466.94	555.65	598.77	572.04	467.40	315.10	205.92	216.39	340.51	466.76	463.38	438.91
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 (95)

Monthly average external temperature from Table U1

4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20
------	------	------	------	-------	-------	-------	-------	-------	-------	------	------

 (96)

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

858.37	838.26	762.72	633.24	481.21	316.57	206.06	216.62	345.40	535.25	709.27	852.43
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (97)

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

291.22	189.92	121.98	44.07	10.28	0.00	0.00	0.00	0.00	50.96	177.04	307.66
$\Sigma(98)1...5, 10...12 =$											1193.11

 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4)

22.01

 (99)

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

 (206)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month											
291.22	189.92	121.98	44.07	10.28	0.00	0.00	0.00	0.00	50.96	177.04	307.66
$\Sigma(211)1...5, 10...12 =$											1193.11

 (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

162.33	143.02	150.04	134.29	131.45	117.23	112.38	123.60	123.48	139.26	147.52	158.36
$\Sigma(219a)1...12 =$											1642.96

 (219)

Annual totals

Space heating fuel - main system 1	1193.11
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Water heating fuel			1642.96	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside		115.72		(230a)
central heating pump or water pump within warm air heating unit		30.00		(230c)
Total electricity for the above, kWh/year			145.72	(231)
Electricity for lighting (Appendix L)			248.95	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =		3230.74	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1193.11	x	13.19	x 0.01 =	157.37	(240)
Water heating	1642.96	x	13.19	x 0.01 =	216.71	(247)
Pumps and fans	145.72	x	13.19	x 0.01 =	19.22	(249)
Electricity for lighting	248.95	x	13.19	x 0.01 =	32.84	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	426.13	(255)

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

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)		1.80	(257)
SAP value		74.83	
SAP rating (section 13)		75	(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	1193.11	x	0.519	=	619.23	(261)
Water heating	1642.96	x	0.519	=	852.70	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1471.92	(265)
Pumps and fans	145.72	x	0.519	=	75.63	(267)
Electricity for lighting	248.95	x	0.519	=	129.21	(268)
Total CO ₂ , kg/year			(265)...(271) =		1676.76	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		30.94	(273)
EI value					77.35	
EI rating (section 14)					77	(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	1193.11	x	3.07	=	3662.85	(261)
Water heating	1642.96	x	3.07	=	5043.89	(264)
Space and water heating			(261) + (262) + (263) + (264) =		8706.74	(265)
Pumps and fans	145.72	x	3.07	=	447.35	(267)
Electricity for lighting	248.95	x	3.07	=	764.29	(268)
Primary energy kWh/year					9918.38	(272)
Dwelling primary energy rate kWh/m ² /year					183.00	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	23/09/2020
Address	18A7 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)	
Lowest occupied	52.20 (1a)	x	2.50 (2a)	=	130.50	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 52.20 (4)					
Dwelling volume					(3a) + (3b) + (3c) + (3d)...(3n) = 130.50	(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				3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)				0.15	(18)
Number of sides on which the dwelling is sheltered				3	(19)
Shelter factor			1 - [0.075 x (19)] =	0.78	(20)
Infiltration rate incorporating shelter factor			(18) x (20) =	0.12	(21)

Infiltration rate modified for monthly wind speed:

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

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

0.15	0.15	0.14	0.13	0.12	0.11	0.11	0.11	0.12	0.12	0.13	0.14
------	------	------	------	------	------	------	------	------	------	------	------

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 75.65 (23c)

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

0.27	0.27	0.26	0.25	0.25	0.23	0.23	0.23	0.24	0.25	0.25	0.26
------	------	------	------	------	------	------	------	------	------	------	------

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

0.27	0.27	0.26	0.25	0.25	0.23	0.23	0.23	0.24	0.25	0.25	0.26
------	------	------	------	------	------	------	------	------	------	------	------

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			2.12	x	1.00	=	2.12	(26)					
Window			6.33	x	1.15	=	7.25	(27)					
External wall			24.76	x	0.18	=	4.46	(29a)					
Party wall			45.60	x	0.00	=	0.00	(32)					
External wall			10.53	x	0.25	=	2.63	(29a)					
Total area of external elements ΣA, m ²			43.74					(31)					
Fabric heat loss, W/K = Σ(A × U)						(26)...(30) + (32) =	16.46	(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							250.00	(35)					
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							8.32	(36)					
Total fabric heat loss						(33) + (36) =	24.78	(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)	11.63	11.50	11.38	10.75	10.62	10.00	10.00	9.87	10.25	10.62	10.88	11.13	(38)
Heat transfer coefficient, W/K (37)m + (38)m	36.41	36.28	36.16	35.53	35.40	34.78	34.78	34.65	35.03	35.40	35.65	35.90	
	Average = Σ(39)1...12/12 =												35.50 (39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.70	0.70	0.69	0.68	0.68	0.67	0.67	0.66	0.67	0.68	0.68	0.69	
	Average = Σ(40)1...12/12 =												0.68 (40)
Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00	(40)

4. Water heating energy requirement

Assumed occupancy, N													1.75	(42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36													75.88	(43)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec		
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)														
	83.47	80.43	77.40	74.36	71.33	68.29	68.29	71.33	74.36	77.40	80.43	83.47		
	Σ(44)1...12 =												910.57	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)														
	123.78	108.26	111.71	97.40	93.45	80.64	74.73	85.75	86.78	101.13	110.39	119.88		
	Σ(45)1...12 =												1193.90	(45)
Distribution loss 0.15 x (45)m														
	18.57	16.24	16.76	14.61	14.02	12.10	11.21	12.86	13.02	15.17	16.56	17.98	(46)	
Storage volume (litres) including any solar or WWHRS storage within same vessel													180.00	(47)
Water storage loss:														
a) If manufacturer's declared loss factor is known (kWh/day)													1.95	(48)
Temperature factor from Table 2b													0.60	(49)
Energy lost from water storage (kWh/day) (48) x (49)													1.17	(50)
Enter (50) or (54) in (55)													1.17	(55)
Water storage loss calculated for each month (55) x (41)m														
	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27	(56)	
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)														
	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27	(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	160.05	141.02	147.98	132.50	129.72	115.74	111.00	122.02	121.88	137.40	145.49	156.15	(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	160.05	141.02	147.98	132.50	129.72	115.74	111.00	122.02	121.88	137.40	145.49	156.15	
	Σ(64)1...12 =												1620.95 (64)
Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m]	70.17	62.20	66.16	60.46	60.09	54.89	53.86	57.53	56.93	62.64	64.78	68.87	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	87.75	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	15.10	13.41	10.91	8.26	6.17	5.21	5.63	7.32	9.82	12.47	14.56	15.52	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	152.94	154.53	150.53	142.02	131.27	121.17	114.42	112.83	116.83	125.35	136.09	146.20	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	31.77	(69)
Pump and fan gains (Table 5a)	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	(70)
Losses e.g. evaporation (Table 5)	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	-70.20	(71)
Water heating gains (Table 5)	94.32	92.57	88.93	83.98	80.77	76.24	72.40	77.32	79.07	84.20	89.98	92.57	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	314.69	312.83	302.69	286.58	270.53	254.95	244.77	249.80	258.05	274.34	292.96	306.61	(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						
South	0.77	x	6.33	x	46.75	x 0.9 x 0.72 x 0.70 = 103.36 (78)						
Solar gains in watts Σ(74)m...(82)m	103.36	169.28	215.64	243.72	253.97	244.41	238.80	231.91	225.26	182.59	122.52	89.32 (83)
Total gains - internal and solar (73)m + (83)m	418.05	482.12	518.33	530.29	524.50	499.36	483.57	481.71	483.31	456.93	415.48	395.93 (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)	0.98	0.95	0.89	0.78	0.62	0.45	0.32	0.33	0.50	0.77	0.95	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													

	20.61	20.75	20.88	20.96	20.99	21.00	21.00	21.00	21.00	20.97	20.80	20.58	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)													
	20.34	20.35	20.35	20.36	20.36	20.37	20.37	20.37	20.37	20.36	20.36	20.35	(88)
Utilisation factor for gains for rest of dwelling n2,m													
	0.98	0.94	0.87	0.74	0.58	0.40	0.27	0.29	0.45	0.73	0.93	0.98	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
	19.84	20.04	20.20	20.32	20.35	20.37	20.37	20.37	20.37	20.33	20.11	19.80	(90)
Living area fraction										Living area ÷ (4) =		0.46	(91)
Mean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2													
	20.19	20.37	20.51	20.62	20.65	20.66	20.66	20.66	20.66	20.62	20.43	20.16	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
	20.04	20.22	20.36	20.47	20.50	20.51	20.51	20.51	20.51	20.47	20.28	20.01	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm													
	0.97	0.94	0.87	0.75	0.59	0.41	0.28	0.30	0.46	0.74	0.93	0.98	(94)
Useful gains, ηmGm, W (94)m x (84)m													
	407.18	451.73	450.65	396.77	309.33	205.43	135.98	142.46	224.15	338.44	387.51	388.21	(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]													
	573.18	555.67	501.20	410.91	311.50	205.53	135.99	142.47	224.43	349.59	469.88	567.69	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
	123.50	69.85	37.61	10.18	1.61	0.00	0.00	0.00	0.00	8.30	59.31	133.54	
	Σ(98)1...5, 10...12 =										443.89	(98)	
Space heating requirement kWh/m²/year										(98) ÷ (4)	8.50	(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													
	123.50	69.85	37.61	10.18	1.61	0.00	0.00	0.00	0.00	8.30	59.31	133.54	
	Σ(211)1...5, 10...12 =										443.89	(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													
	160.05	141.02	147.98	132.50	129.72	115.74	111.00	122.02	121.88	137.40	145.49	156.15	
	Σ(219a)1...12 =										1620.95	(219)	

Annual totals													
Space heating fuel - main system 1												443.89	

Water heating fuel												1620.95	
Electricity for pumps, fans and electric keep-hot (Table 4f)													
mechanical ventilation fans - balanced, extract or positive input from outside												119.41	(230a)
central heating pump or water pump within warm air heating unit												30.00	(230c)
Total electricity for the above, kWh/year												149.41	(231)
Electricity for lighting (Appendix L)												266.66	(232)
Total delivered energy for all uses												(211)...(221) + (231) + (232)...(237b) =	2480.91 (238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	443.89	x	13.19	x 0.01 =	58.55	(240)
Water heating	1620.95	x	13.19	x 0.01 =	213.80	(247)
Pumps and fans	149.41	x	13.19	x 0.01 =	19.71	(249)
Electricity for lighting	266.66	x	13.19	x 0.01 =	35.17	(250)
Additional standing charges					0.00	(251)
Total energy cost					(240)...(242) + (245)...(254) =	327.23 (255)

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

Energy cost deflator (Table 12)												0.42	(256)
Energy cost factor (ECF)												1.41	(257)
SAP value												80.28	
SAP rating (section 13)												80	(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	443.89	x	0.519	=	230.38	(261)
Water heating	1620.95	x	0.519	=	841.27	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1071.65	(265)
Pumps and fans	149.41	x	0.519	=	77.54	(267)
Electricity for lighting	266.66	x	0.519	=	138.40	(268)
Total CO ₂ , kg/year				(265)...(271) =	1287.59	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	24.67	(273)
EI value					82.25	
EI rating (section 14)					82	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	443.89	x	3.07	=	1362.76	(261)
Water heating	1620.95	x	3.07	=	4976.31	(264)
Space and water heating					(261) + (262) + (263) + (264) =	6339.06 (265)
Pumps and fans	149.41	x	3.07	=	458.68	(267)
Electricity for lighting	266.66	x	3.07	=	818.65	(268)
Primary energy kWh/year					7616.39	(272)
Dwelling primary energy rate kWh/m2/year					145.91	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	23/09/2020
Address	2BA8 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	62.00 (1a) x	2.50 (2a) =	155.00 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 62.00 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	155.00 (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 fuelless gas fires	0 x 40 =	0 (7c)

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

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

Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area	3.00 (17)
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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) = 0.13 (21)
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Infiltration rate modified for monthly wind speed:

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

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.93	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	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.13	0.14	0.14	0.15
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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	74.80 (23c)
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a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28
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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	2.12	x	1.00	=	2.12		(26)
Window	13.48	x	1.15	=	15.44		(27)
External wall	52.04	x	0.18	=	9.37		(29a)
Party wall	29.84	x	0.00	=	0.00		(32)
Total area of external elements ΣA, m ²	67.64						(31)

Fabric heat loss, W/K = Σ(A x U)	(26)...(30) + (32) =	26.92 (33)
Heat capacity Cm = Σ(A x k)	(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m ² K		250.00 (35)
Thermal bridges: Σ(L x Ψ) calculated using Appendix K		11.21 (36)
Total fabric heat loss	(33) + (36) =	38.13 (37)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)												
14.76	14.60	14.43	13.62	13.46	12.64	12.64	12.48	12.97	13.46	13.78	14.11	(38)

Heat transfer coefficient, W/K (37)m + (38)m	52.89	52.73	52.56	51.75	51.58	50.77	50.77	50.61	51.10	51.58	51.91	52.24
Average = Σ(39)1...12/12 =	51.71 (39)											

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.85	0.85	0.85	0.83	0.83	0.82	0.82	0.82	0.82	0.83	0.84	0.84
Average = Σ(40)1...12/12 =	0.83 (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	2.04 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	82.59 (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)												
90.85	87.55	84.24	80.94	77.64	74.33	74.33	77.64	80.94	84.24	87.55	90.85	
										Σ(44)1...12 =	991.11	(44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	134.73	117.84	121.60	106.01	101.72	87.78	81.34	93.34	94.45	110.07	120.15	130.48
Σ(45)1...12 =	1299.50 (45)											

Distribution loss 0.15 x (45)m	20.21	17.68	18.24	15.90	15.26	13.17	12.20	14.00	14.17	16.51	18.02	19.57
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Storage volume (litres) including any solar or WWHRS storage within same vessel	180.00 (47)
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Water storage loss:	
a) If manufacturer's declared loss factor is known (kWh/day)	1.95 (48)
Temperature factor from Table 2b	0.60 (49)
Energy lost from water storage (kWh/day) (48) x (49)	1.17 (50)
Enter (50) or (54) in (55)	1.17 (55)

Water storage loss calculated for each month (55) x (41)m	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27
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Primary circuit loss for each month from Table 3

Water heating fuel			1726.55	
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside		144.19		(230a)
central heating pump or water pump within warm air heating unit		30.00		(230c)
Total electricity for the above, kWh/year			174.19	(231)
Electricity for lighting (Appendix L)			280.41	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =		3271.21	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1090.06	x	13.19	x 0.01 =	143.78	(240)
Water heating	1726.55	x	13.19	x 0.01 =	227.73	(247)
Pumps and fans	174.19	x	13.19	x 0.01 =	22.98	(249)
Electricity for lighting	280.41	x	13.19	x 0.01 =	36.99	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	431.47	(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		76.37	
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	1090.06	x	0.519	=	565.74	(261)
Water heating	1726.55	x	0.519	=	896.08	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1461.82	(265)
Pumps and fans	174.19	x	0.519	=	90.40	(267)
Electricity for lighting	280.41	x	0.519	=	145.53	(268)
Total CO ₂ , kg/year			(265)...(271) =		1697.76	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		27.38	(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	1090.06	x	3.07	=	3346.49	(261)
Water heating	1726.55	x	3.07	=	5300.52	(264)
Space and water heating			(261) + (262) + (263) + (264) =		8647.00	(265)
Pumps and fans	174.19	x	3.07	=	534.76	(267)
Electricity for lighting	280.41	x	3.07	=	860.85	(268)
Primary energy kWh/year					10042.61	(272)
Dwelling primary energy rate kWh/m ² /year					161.98	(273)

DER Worksheet Design - Draft



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Assessor name	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	23/09/2020
Address	2BA9 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)	
Lowest occupied	64.90 (1a)	x	2.50 (2a)	=	162.25	(3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 64.90 (4)					
Dwelling volume			(3a) + (3b) + (3c) + (3d)...(3n) =		162.25	(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	3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.15	(18)
Number of sides on which the dwelling is sheltered	2	(19)
Shelter factor	1 - [0.075 x (19)] = 0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.13	(21)

Infiltration rate modified for monthly wind speed:

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

Wind factor (22)m ÷ 4

1.28	1.25	1.23	1.10	1.08	0.95	0.95	0.93	1.00	1.08	1.13	1.18	(22a)
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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15	(22b)
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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 74.80 (23c)

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

0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28	(24a)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28	(25)
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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			2.12	x 1.00	= 2.12		(26)						
Window			16.07	x 1.15	= 18.40		(27)						
External wall			34.06	x 0.18	= 6.13		(29a)						
Party wall			41.18	x 0.00	= 0.00		(32)						
Total area of external elements ΣA, m ²			52.25				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	26.65	(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						7.98	(36)						
Total fabric heat loss					(33) + (36) =	34.63	(37)						
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	15.45	15.28	15.11	14.26	14.09	13.23	13.23	13.06	13.57	14.09	14.43	14.77	(38)
Heat transfer coefficient, W/K (37)m + (38)m	50.08	49.91	49.74	48.88	48.71	47.86	47.86	47.69	48.20	48.71	49.05	49.39	
	Average = Σ(39)1...12/12 = 48.84												(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.77	0.77	0.77	0.75	0.75	0.74	0.74	0.73	0.74	0.75	0.76	0.76	
	Average = Σ(40)1...12/12 = 0.75												(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	2.12	(42)											
Annual average hot water usage in litres per day Vd,average = (25 × N) + 36	84.46	(43)											
Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
	92.91	89.53	86.15	82.77	79.39	76.02	76.02	79.39	82.77	86.15	89.53	92.91	
	Σ(44)1...12 = 1013.53												(44)
Energy content of hot water used = 4.18 × Vd,m × nm × Tm/3600 kWh/month (see Tables 1b, 1c 1d)	137.78	120.50	124.35	108.41	104.02	89.76	83.18	95.45	96.59	112.56	122.87	133.43	
	Σ(45)1...12 = 1328.90												(45)
Distribution loss 0.15 x (45)m	20.67	18.08	18.65	16.26	15.60	13.46	12.48	14.32	14.49	16.88	18.43	20.01	(46)
Storage volume (litres) including any solar or WWHRS storage within same vessel	180.00												(47)
Water storage loss:													
a) If manufacturer's declared loss factor is known (kWh/day)	1.95												(48)
Temperature factor from Table 2b	0.60												(49)
Energy lost from water storage (kWh/day) (48) x (49)	1.17												(50)
Enter (50) or (54) in (55)	1.17												(55)
Water storage loss calculated for each month (55) x (41)m	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27	(56)
If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27	(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)
------	------	------	------	------	------	------	------	------	------	------	------	------	------

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

174.05	153.26	160.62	143.51	140.29	124.86	119.45	131.72	131.69	148.83	157.97	169.70	(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

174.05	153.26	160.62	143.51	140.29	124.86	119.45	131.72	131.69	148.83	157.97	169.70	(64)
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	------

Σ(64)1...12 = 1755.95

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

74.83	66.28	70.36	64.13	63.60	57.93	56.67	60.75	60.20	66.44	68.94	73.38	(65)
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5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	105.81	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	16.50	14.66	11.92	9.02	6.75	5.70	6.15	8.00	10.74	13.63	15.91	16.96	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	185.11	187.04	182.19	171.89	158.88	146.66	138.49	136.57	141.41	151.71	164.72	176.95	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	33.58	(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)	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	-84.65	(71)
Water heating gains (Table 5)	100.57	98.62	94.57	89.06	85.49	80.45	76.17	81.66	83.60	89.31	95.74	98.63	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	359.94	358.06	346.43	327.72	308.86	290.55	278.56	283.97	293.49	312.39	334.12	350.28	(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 13.73	x 36.79	x 0.9 x 0.72	x 0.70	= 176.44	(77)						
East	0.77	x 2.34	x 19.64	x 0.9 x 0.72	x 0.70	= 16.05	(76)						
Solar gains in watts Σ(74)m...(82)m	192.50	331.95	462.94	584.95	663.15	661.21	636.33	577.98	505.42	369.43	231.36	164.20	(83)
Total gains - internal and solar (73)m + (83)m	552.43	690.01	809.37	912.67	972.01	951.76	914.89	861.95	798.91	681.83	565.47	514.48	(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)	0.98	0.93	0.82	0.64	0.47	0.32	0.23	0.25	0.42	0.72	0.94	0.99	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)													

20.54	20.75	20.91	20.98	21.00	21.00	21.00	21.00	21.00	20.97	20.77	20.50	(87)	
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)													
20.28	20.28	20.28	20.29	20.30	20.31	20.31	20.31	20.30	20.30	20.29	20.29	(88)	
Utilisation factor for gains for rest of dwelling n2,m													
0.98	0.92	0.79	0.60	0.43	0.29	0.19	0.22	0.37	0.68	0.93	0.98	(89)	
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)													
19.68	19.97	20.18	20.28	20.30	20.31	20.31	20.31	20.30	20.27	20.01	19.63	(90)	
Living area fraction													
Living area ÷ (4) =												0.39	(91)
Mean internal temperature for the whole dwelling fLA x T1 + (1 - fLA) x T2													
20.02	20.28	20.47	20.55	20.57	20.58	20.58	20.58	20.57	20.55	20.31	19.97	(92)	
Apply adjustment to the mean internal temperature from Table 4e where appropriate													
19.87	20.13	20.32	20.40	20.42	20.43	20.43	20.43	20.42	20.40	20.16	19.82	(93)	

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Utilisation factor for gains, ηm														
0.97	0.91	0.79	0.61	0.44	0.29	0.20	0.22	0.38	0.68	0.92	0.98	(94)		
Useful gains, ηmGm, W (94)m x (84)m														
537.01	630.16	642.37	555.45	424.10	278.87	183.19	192.14	304.66	465.41	522.64	504.38	(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]														
779.61	759.86	687.14	562.36	424.73	278.90	183.19	192.14	304.84	477.13	640.46	771.42	(97)		
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m														
180.49	87.15	33.31	4.98	0.47	0.00	0.00	0.00	0.00	8.72	84.83	198.68			
												Σ(98)1...5, 10...12 =	598.63	(98)
												(98) ÷ (4)	9.22	(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														
180.49	87.15	33.31	4.98	0.47	0.00	0.00	0.00	0.00	8.72	84.83	198.68			
												Σ(211)1...5, 10...12 =	598.63	(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)
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Water heating fuel, kWh/month

174.05	153.26	160.62	143.51	140.29	124.86	119.45	131.72	131.69	148.83	157.97	169.70			
												Σ(219a)1...12 =	1755.95	(219)

Annual totals

Space heating fuel - main system 1	598.63
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Water heating fuel	1755.95		
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	150.93	(230a)	
central heating pump or water pump within warm air heating unit	30.00	(230c)	
Total electricity for the above, kWh/year	180.93	(231)	
Electricity for lighting (Appendix L)	291.45	(232)	
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	2826.97	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	598.63	x	13.19	x 0.01 =	78.96	(240)
Water heating	1755.95	x	13.19	x 0.01 =	231.61	(247)
Pumps and fans	180.93	x	13.19	x 0.01 =	23.87	(249)
Electricity for lighting	291.45	x	13.19	x 0.01 =	38.44	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	372.88	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	1.43	(257)
SAP value	80.12	
SAP rating (section 13)	80	(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	598.63	x	0.519	=	310.69	(261)
Water heating	1755.95	x	0.519	=	911.34	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1222.03	(265)
Pumps and fans	180.93	x	0.519	=	93.90	(267)
Electricity for lighting	291.45	x	0.519	=	151.26	(268)
Total CO ₂ , kg/year				(265)...(271) =	1467.20	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	22.61	(273)
EI value					82.11	
EI rating (section 14)					82	(274)
EI band					B	

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

	Energy kWh/year		Primary factor		Primary Energy kWh/year	
Space heating - main system 1	598.63	x	3.07	=	1837.81	(261)
Water heating	1755.95	x	3.07	=	5390.78	(264)
Space and water heating			(261) + (262) + (263) + (264) =		7228.59	(265)
Pumps and fans	180.93	x	3.07	=	555.46	(267)
Electricity for lighting	291.45	x	3.07	=	894.75	(268)
Primary energy kWh/year					8678.80	(272)
Dwelling primary energy rate kWh/m2/year					133.73	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	23/09/2020
Address	2BA11 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	73.25 (1a) x	2.50 (2a) =	183.13 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 73.25 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	183.13 (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	3.00 (17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.15 (18)
Number of sides on which the dwelling is sheltered	2 (19)
Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.13 (21)

Infiltration rate modified for monthly wind speed:

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

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	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.12	0.13	0.14	0.14	0.15
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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	74.80 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28
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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			2.12	x 1.00	= 2.12		(26)
Window			15.84	x 1.15	= 18.14		(27)
Exposed floor			73.25	x 0.15	= 10.99		(28b)
External wall			23.19	x 0.18	= 4.17		(29a)
Party wall			48.44	x 0.00	= 0.00		(32)
External wall			17.15	x 0.25	= 4.29		(29a)
Total area of external elements ΣA, m ²			131.55				(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)	17.44	17.25	17.05	16.09	15.90	14.93	14.93	14.74	15.32	15.90	16.28	16.67

Heat transfer coefficient, W/K (37)m + (38)m	75.15	74.96	74.77	73.81	73.61	72.65	72.65	72.46	73.04	73.61	74.00	74.38
Average = Σ(39)1...12/12 =	73.76 (39)											

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.03	1.02	1.02	1.01	1.00	0.99	0.99	0.99	1.00	1.00	1.01	1.02
Average = Σ(40)1...12/12 =	1.01 (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	2.32 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	89.36 (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)	98.29	94.72	91.14	87.57	83.99	80.42	80.42	83.99	87.57	91.14	94.72	98.29
Σ(44)1...12 =	1072.28 (44)											

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	145.76	127.49	131.55	114.69	110.05	94.96	88.00	100.98	102.19	119.09	129.99	141.16
Σ(45)1...12 =	1405.92 (45)											

Distribution loss 0.15 x (45)m	21.86	19.12	19.73	17.20	16.51	14.24	13.20	15.15	15.33	17.86	19.50	21.17
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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)	1.95 (48)
Temperature factor from Table 2b	0.60 (49)
Energy lost from water storage (kWh/day) (48) x (49)	1.17 (50)
Enter (50) or (54) in (55)	1.17 (55)

Water storage loss calculated for each month (55) x (41)m	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27
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If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)

	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27	(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													
	182.03	160.25	167.82	149.79	146.32	130.06	124.27	137.25	137.29	155.36	165.09	177.43	(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													
	182.03	160.25	167.82	149.79	146.32	130.06	124.27	137.25	137.29	155.36	165.09	177.43	
										$\Sigma(64)1...12 =$	1832.97	(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]													
	77.48	68.60	72.76	66.22	65.61	59.66	58.28	62.59	62.06	68.61	71.30	75.95	(65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)													
	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5													
	18.27	16.23	13.20	9.99	7.47	6.31	6.81	8.86	11.89	15.09	17.62	18.78	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5													
	204.76	206.89	201.53	190.13	175.74	162.22	153.19	151.06	156.41	167.81	182.20	195.73	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5													
	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	(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)													
	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	(71)
Water heating gains (Table 5)													
	104.14	102.08	97.79	91.97	88.18	82.86	78.33	84.13	86.19	92.22	99.03	102.09	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m													
	388.01	386.03	373.36	352.93	332.23	312.22	299.16	304.88	315.33	335.96	359.69	377.43	(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	
North		0.77	x	9.51	x	10.63	x 0.9 x	0.72	x	0.70	=	35.32	(74)
South		0.77	x	3.99	x	46.75	x 0.9 x	0.72	x	0.70	=	65.15	(78)
NorthEast		0.77	x	2.34	x	11.28	x 0.9 x	0.72	x	0.70	=	9.22	(75)
Solar gains in watts $\Sigma(74)m...(82)m$													
	109.69	192.97	284.44	393.39	482.91	499.33	473.03	402.33	321.10	218.38	132.40	93.27	(83)
Total gains - internal and solar (73)m + (83)m													
	497.71	579.00	657.79	746.32	815.15	811.55	772.19	707.21	636.42	554.34	492.09	470.70	(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1(°C)												21.00	(85)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	

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

1.00	0.99	0.97	0.91	0.77	0.56	0.41	0.47	0.74	0.95	0.99	1.00	(86)
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Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)

20.00	20.17	20.42	20.72	20.92	20.99	21.00	21.00	20.95	20.68	20.29	19.97	(87)
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Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)

20.06	20.06	20.07	20.08	20.08	20.09	20.09	20.09	20.09	20.08	20.07	20.07	(88)
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Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.97	0.89	0.71	0.49	0.33	0.38	0.66	0.93	0.99	1.00	(89)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

18.74	18.98	19.34	19.76	20.01	20.08	20.09	20.09	20.05	19.73	19.16	18.70	(90)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

Living area fraction

Living area ÷ (4) = 0.44 (91)

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

19.30	19.51	19.82	20.19	20.41	20.49	20.49	20.49	20.45	20.15	19.66	19.27	(92)
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	------

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

19.15	19.36	19.67	20.04	20.26	20.34	20.34	20.34	20.30	20.00	19.51	19.12	(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	0.96	0.89	0.72	0.51	0.35	0.40	0.68	0.93	0.99	1.00	(94)
Useful gains, ηmGm, W (94)m x (84)m													
	494.47	570.41	632.57	661.40	588.98	411.99	271.48	284.75	431.56	513.01	484.96	468.39	(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]													
	1116.06	1083.77	984.53	822.14	630.36	416.68	271.96	285.74	452.96	692.07	918.51	1109.57	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m													
	462.46	344.98	261.86	115.73	30.79	0.00	0.00	0.00	0.00	133.22	312.15	477.04	
										$\Sigma(98)1...5, 10...12 =$	2138.22	(98)	
Space heating requirement kWh/m ² /year										(98) ÷ (4)	29.19	(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													
	462.46	344.98	261.86	115.73	30.79	0.00	0.00	0.00	0.00	133.22	312.15	477.04	
										$\Sigma(211)1...5, 10...12 =$	2138.22	(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	100.00	(217)
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Water heating fuel, kWh/month

182.03	160.25	167.82	149.79	146.32	130.06	124.27	137.25	137.29	155.36	165.09	177.43	
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	$\Sigma(219a)1...12 =$	1832.97	(219)
Annual totals			
Space heating fuel - main system 1		2138.22	
Water heating fuel		1832.97	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	170.35		(230a)
central heating pump or water pump within warm air heating unit	30.00		(230c)
Total electricity for the above, kWh/year		200.35	(231)
Electricity for lighting (Appendix L)		322.71	(232)
Total delivered energy for all uses	$(211)...(221) + (231) + (232)...(237b) =$	4494.26	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2138.22	x	13.19	x 0.01 =	282.03	(240)
Water heating	1832.97	x	13.19	x 0.01 =	241.77	(247)
Pumps and fans	200.35	x	13.19	x 0.01 =	26.43	(249)
Electricity for lighting	322.71	x	13.19	x 0.01 =	42.57	(250)
Additional standing charges					0.00	(251)
Total energy cost				$(240)...(242) + (245)...(254) =$	592.79	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	2.11	(257)
SAP value	70.63	
SAP rating (section 13)	71	(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	2138.22	x	0.519	=	1109.74	(261)
Water heating	1832.97	x	0.519	=	951.31	(264)
Space and water heating			$(261) + (262) + (263) + (264) =$		2061.05	(265)
Pumps and fans	200.35	x	0.519	=	103.98	(267)
Electricity for lighting	322.71	x	0.519	=	167.49	(268)
Total CO ₂ , kg/year				$(265)...(271) =$	2332.52	(272)
Dwelling CO ₂ emission rate				$(272) \div (4) =$	31.84	(273)
Ei value					73.57	
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	2138.22	x	3.07	=	6564.35	(261)
Water heating	1832.97	x	3.07	=	5627.23	(264)
Space and water heating			$(261) + (262) + (263) + (264) =$		12191.58	(265)
Pumps and fans	200.35	x	3.07	=	615.08	(267)
Electricity for lighting	322.71	x	3.07	=	990.72	(268)

Primary energy kWh/year	13797.38	(272)
Dwelling primary energy rate kWh/m ² /year	188.36	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	23/09/2020
Address	2BA11 Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	73.25 (1a) x	2.50 (2a) =	183.13 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 73.25 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	183.13 (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	3.00 (17)
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If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.15 (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) = 0.13 (21)
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Infiltration rate modified for monthly wind speed:

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

Wind factor (22)m ÷ 4	1.28	1.25	1.23	1.10	1.08	0.95	0.93	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	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.13	0.14	0.14	0.15
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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	74.80 (23c)
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a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)	0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28
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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			2.12 x	1.00 =	2.12		(26)
Window			15.84 x	1.15 =	18.14		(27)
External wall			23.19 x	0.18 =	4.17		(29a)
Party wall			48.44 x	0.00 =	0.00		(32)
External wall			17.15 x	0.25 =	4.29		(29a)
Total area of external elements ΣA, m ²			58.30				(31)
Fabric heat loss, W/K = Σ(A x U)						(26)...(30) + (32) =	28.72 (33)
Heat capacity Cm = Σ(A x k)						(28)...(30) + (32) + (32a)...(32e) =	N/A (34)
Thermal mass parameter (TMP) in kJ/m ² K							250.00 (35)
Thermal bridges: Σ(L x Ψ) calculated using Appendix K							10.62 (36)
Total fabric heat loss						(33) + (36) =	39.34 (37)

Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	17.44	17.25	17.05	16.09	15.90	14.93	14.93	14.74	15.32	15.90	16.28	16.67
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Heat transfer coefficient, W/K (37)m + (38)m	56.77	56.58	56.39	55.43	55.23	54.27	54.27	54.08	54.66	55.23	55.62	56.00
Average = Σ(39)1...12/12 =	55.38 (39)											

Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	0.78	0.77	0.77	0.76	0.75	0.74	0.74	0.74	0.75	0.75	0.76	0.76
Average = Σ(40)1...12/12 =	0.76 (40)											

Number of days in month (Table 1a)	31.00	28.00	31.00	30.00	31.00	30.00	31.00	31.00	30.00	31.00	30.00	31.00
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4. Water heating energy requirement

Assumed occupancy, N	2.32 (42)
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	89.36 (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)	98.29	94.72	91.14	87.57	83.99	80.42	83.99	87.57	91.14	94.72	98.29
Σ(44)1...12 =	1072.28 (44)										

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	145.76	127.49	131.55	114.69	110.05	94.96	88.00	100.98	102.19	119.09	129.99	141.16
Σ(45)1...12 =	1405.92 (45)											

Distribution loss 0.15 x (45)m	21.86	19.12	19.73	17.20	16.51	14.24	13.20	15.15	15.33	17.86	19.50	21.17
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Storage volume (litres) including any solar or WWHRS storage within same vessel	180.00 (47)
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Water storage loss:	
a) If manufacturer's declared loss factor is known (kWh/day)	1.95 (48)
Temperature factor from Table 2b	0.60 (49)
Energy lost from water storage (kWh/day) (48) x (49)	1.17 (50)
Enter (50) or (54) in (55)	1.17 (55)

Water storage loss calculated for each month (55) x (41)m	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27
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If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56)	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27
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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	0.00
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 (59)

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

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
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 (61)

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

182.03	160.25	167.82	149.79	146.32	130.06	124.27	137.25	137.29	155.36	165.09	177.43
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 (62)

Solar DHW input calculated using Appendix G or Appendix H

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

 (63)

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

182.03	160.25	167.82	149.79	146.32	130.06	124.27	137.25	137.29	155.36	165.09	177.43
									$\Sigma(64)1...12 =$	1832.97	

 (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	68.60	72.76	66.22	65.61	59.66	58.28	62.59	62.06	68.61	71.30	75.95
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 (65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains (Table 5)	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12	116.12

 (66)

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

18.27	16.23	13.20	9.99	7.47	6.31	6.81	8.86	11.89	15.09	17.62	18.78
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 (67)

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

204.76	206.89	201.53	190.13	175.74	162.22	153.19	151.06	156.41	167.81	182.20	195.73
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 (68)

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

34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61	34.61
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 (69)

Pump and fan gains (Table 5a)

3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
------	------	------	------	------	------	------	------	------	------	------	------

 (70)

Losses e.g. evaporation (Table 5)

-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89	-92.89
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 (71)

Water heating gains (Table 5)

104.14	102.08	97.79	91.97	88.18	82.86	78.33	84.13	86.19	92.22	99.03	102.09
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 (72)

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

388.01	386.03	373.36	352.93	332.23	312.22	299.16	304.88	315.33	335.96	359.69	377.43
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 (73)

6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W
North	0.77	x 9.51	x 10.63	x 0.9 x 0.72	x 0.70	= 35.32
South	0.77	x 3.99	x 46.75	x 0.9 x 0.72	x 0.70	= 65.15
NorthEast	0.77	x 2.34	x 11.28	x 0.9 x 0.72	x 0.70	= 9.22

 (74) (75)

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

109.69	192.97	284.44	393.39	482.91	499.33	473.03	402.33	321.10	218.38	132.40	93.27
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 (83)

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

497.71	579.00	657.79	746.32	815.15	811.55	772.19	707.21	636.42	554.34	492.09	470.70
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 (84)

7. Mean internal temperature (heating season)

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

21.00

 (85)

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

0.99	0.98	0.95	0.83	0.62	0.43	0.31	0.35	0.59	0.89	0.98	1.00
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 (86)

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

20.38	20.53	20.73	20.92	20.99	21.00	21.00	21.00	21.00	20.89	20.60	20.35
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 (87)

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

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

Utilisation factor for gains for rest of dwelling n2,m

0.99	0.98	0.94	0.79	0.58	0.38	0.26	0.30	0.53	0.86	0.98	1.00
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 (89)

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

19.44	19.67	19.95	20.21	20.28	20.30	20.30	20.31	20.30	20.18	19.78	19.41
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 (90)

Living area fraction

Living area ÷ (4) =	0.44
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 (91)

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

19.86	20.05	20.30	20.53	20.60	20.61	20.61	20.61	20.61	20.49	20.15	19.83
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 (92)

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

19.71	19.90	20.15	20.38	20.45	20.46	20.46	20.46	20.46	20.34	20.00	19.68
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 (93)

8. Space heating requirement

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation factor for gains, ηm											
0.99	0.98	0.93	0.80	0.59	0.39	0.27	0.31	0.54	0.86	0.98	0.99

 (94)

Useful gains, ηmGm, W (94)m x (84)m

493.46	565.69	613.42	594.69	478.42	317.98	209.67	219.79	345.42	478.82	480.90	467.79
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (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]

874.77	848.75	769.69	636.16	483.19	318.20	209.68	219.82	347.45	538.15	717.22	866.81
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (97)

Space heating requirement, kWh/month $0.024 \times [(97)\text{m} - (95)\text{m}] \times (41)\text{m}$

283.70	190.21	116.26	29.86	3.55	0.00	0.00	0.00	0.00	44.14	170.15	296.88
									$\Sigma(98)1...5, 10...12 =$	1134.75	

 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4)	15.49
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 (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
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 (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											
283.70	190.21	116.26	29.86	3.55	0.00	0.00	0.00	0.00	44.14	170.15	296.88
									$\Sigma(211)1...5, 10...12 =$	1134.75	

 (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

182.03	160.25	167.82	149.79	146.32	130.06	124.27	137.25	137.29	155.36	165.09	177.43
									$\Sigma(219a)1...12 =$	1832.97	

 (219)

Annual totals

Space heating fuel - main system 1				1134.75	
Water heating fuel				1832.97	
Electricity for pumps, fans and electric keep-hot (Table 4f)					
mechanical ventilation fans - balanced, extract or positive input from outside		170.35			(230a)
central heating pump or water pump within warm air heating unit		30.00			(230c)
Total electricity for the above, kWh/year				200.35	(231)
Electricity for lighting (Appendix L)				322.71	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =			3490.78	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	1134.75	x	13.19	x 0.01 =	149.67	(240)
Water heating	1832.97	x	13.19	x 0.01 =	241.77	(247)
Pumps and fans	200.35	x	13.19	x 0.01 =	26.43	(249)
Electricity for lighting	322.71	x	13.19	x 0.01 =	42.57	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	460.43	(255)

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

Energy cost deflator (Table 12)		0.42	(256)
Energy cost factor (ECF)		1.64	(257)
SAP value		77.19	
SAP rating (section 13)		77	(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	1134.75	x	0.519	=	588.93	(261)
Water heating	1832.97	x	0.519	=	951.31	(264)
Space and water heating			(261) + (262) + (263) + (264) =		1540.25	(265)
Pumps and fans	200.35	x	0.519	=	103.98	(267)
Electricity for lighting	322.71	x	0.519	=	167.49	(268)
Total CO ₂ , kg/year			(265)...(271) =		1811.72	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		24.73	(273)
EI value					79.47	
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	1134.75	x	3.07	=	3483.67	(261)
Water heating	1832.97	x	3.07	=	5627.23	(264)
Space and water heating			(261) + (262) + (263) + (264) =		9110.90	(265)
Pumps and fans	200.35	x	3.07	=	615.08	(267)
Electricity for lighting	322.71	x	3.07	=	990.72	(268)
Primary energy kWh/year					10716.70	(272)

Dwelling primary energy rate kWh/m2/year

146.30 (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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	23/09/2020
Address	3BA1 TF Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)	Average storey height (m)	Volume (m ³)
Lowest occupied	75.25 (1a) x	2.50 (2a) =	188.13 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 75.25 (4)		
Dwelling volume		(3a) + (3b) + (3c) + (3d)...(3n) =	188.13 (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	3.00 (17)
---	-----------

If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.15 (18)
--	-----------

Number of sides on which the dwelling is sheltered	2 (19)
--	--------

Shelter factor	1 - [0.075 x (19)] = 0.85 (20)
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Infiltration rate incorporating shelter factor	(18) x (20) = 0.13 (21)
--	-------------------------

Infiltration rate modified for monthly wind speed:

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
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 (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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Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m (22a)

	0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.13	0.14	0.14	0.15
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Calculate effective air change rate for the applicable case: (22b)

If mechanical ventilation: air change rate through system	0.50 (23a)
---	------------

If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h	74.80 (23c)
--	-------------

a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100]	0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28
--	------	------	------	------	------	------	------	------	------	------	------	------

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

	0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28
--	------	------	------	------	------	------	------	------	------	------	------	------

(25)

3. Heat losses and heat loss parameter

Element	Gross area, 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			2.12	x 1.00	= 2.12		(26)
Window			12.75	x 1.15	= 14.60		(27)
External wall			47.91	x 0.18	= 8.62		(29a)
Party wall			55.08	x 0.00	= 0.00		(32)
Roof			75.25	x 0.12	= 9.03		(30)
Total area of external elements ΣA, m ²			138.03				(31)

Fabric heat loss, W/K = Σ(A x U)	(26)...(30) + (32) =	34.37
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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		250.00
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(35)

Thermal bridges: Σ(L x Ψ) calculated using Appendix K		23.08
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(36)

Total fabric heat loss	(33) + (36) =	57.45
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(37)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
17.91	17.72	17.52	16.53	16.33	15.34	15.34	15.14	15.74	16.33	16.73	17.12

Ventilation heat loss calculated monthly 0.33 x (25)m x (5) (38)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
75.36	75.17	74.97	73.98	73.78	72.79	72.79	72.59	73.19	73.78	74.18	74.57

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

Average = Σ(39)1...12/12 = 73.93 (39)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1.00	1.00	1.00	0.98	0.98	0.97	0.97	0.96	0.97	0.98	0.99	0.99

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

Average = Σ(40)1...12/12 = 0.98 (40)

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

Number of days in month (Table 1a) (40)

4. Water heating energy requirement

Assumed occupancy, N	2.37
Annual average hot water usage in litres per day Vd,average = (25 x N) + 36	90.41

(42) (43)

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
99.45	95.83	92.21	88.60	84.98	81.37	81.37	84.98	88.60	92.21	95.83	99.45

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

Σ(44)1...12 = 1084.87 (44)

Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d)	147.48	128.98	133.10	116.04	111.34	96.08	89.03	102.17	103.39	120.49	131.52	142.82
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Σ(45)1...12 = 1422.44 (45)

Distribution loss 0.15 x (45)m	22.12	19.35	19.96	17.41	16.70	14.41	13.35	15.32	15.51	18.07	19.73	21.42
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(46)

Storage volume (litres) including any solar or WWHRs storage within same vessel	180.00
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(47)

Water storage loss:	
a) If manufacturer's declared loss factor is known (kWh/day)	1.95
Temperature factor from Table 2b	0.60
Energy lost from water storage (kWh/day) (48) x (49)	1.17
Enter (50) or (54) in (55)	1.17

(48) (49) (50) (55)

Water storage loss calculated for each month (55) x (41)m	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27
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(56)

If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)	36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27
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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	0.00
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 (59)

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

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

 (61)

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

183.75	161.74	169.37	151.14	147.61	131.18	125.30	138.44	138.49	156.76	166.62	179.09
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 (62)

Solar DHW input calculated using Appendix G or Appendix H

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

 (63)

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

183.75	161.74	169.37	151.14	147.61	131.18	125.30	138.44	138.49	156.76	166.62	179.09
$\Sigma(64)1...12 =$											1849.49

 (64)

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

78.05	69.10	73.27	66.66	66.04	60.03	58.62	62.99	62.46	69.08	71.81	76.50
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 (65)

5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Metabolic gains (Table 5)	118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33	118.33

 (66)

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

19.25	17.10	13.90	10.53	7.87	6.64	7.18	9.33	12.52	15.90	18.56	19.78
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 (67)

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

209.23	211.40	205.93	194.28	179.58	165.76	156.53	154.36	159.83	171.47	186.18	200.00
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 (68)

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

34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83	34.83
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 (69)

Pump and fan gains (Table 5a)

3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
------	------	------	------	------	------	------	------	------	------	------	------

 (70)

Losses e.g. evaporation (Table 5)

-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66	-94.66
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------

 (71)

Water heating gains (Table 5)

104.91	102.82	98.48	92.59	88.76	83.37	78.79	84.66	86.74	92.85	99.74	102.83
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 (72)

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

394.88	392.82	379.81	358.89	337.70	317.27	303.99	309.84	320.59	341.72	365.97	384.11
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 (73)

6. Solar gains

	Access factor Table 6d	Area m ²	Solar flux W/m ²	g specific data or Table 6b	FF specific data or Table 6c	Gains W						
North	0.77	x 8.07	x 10.63	x 0.9 x 0.72	x 0.70	= 29.97 (74)						
South	0.77	x 4.68	x 46.75	x 0.9 x 0.72	x 0.70	= 76.42 (78)						
Solar gains in watts $\Sigma(74)\text{m}...(82)\text{m}$												
	106.39	182.43	256.76	336.52	398.36	406.15	387.04	338.45	283.56	203.17	127.56	91.02 (83)

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

501.28	575.25	636.57	695.42	736.07	723.42	691.03	648.30	604.15	544.90	493.53	475.13
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 (84)

7. Mean internal temperature (heating season)

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

21.00

 (85)

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

1.00	0.99	0.98	0.94	0.82	0.63	0.46	0.51	0.77	0.95	0.99	1.00
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 (86)

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

20.03	20.18	20.40	20.69	20.89	20.98	21.00	21.00	20.95	20.68	20.30	20.00
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 (87)

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

20.08	20.08	20.09	20.10	20.10	20.11	20.11	20.11	20.11	20.10	20.10	20.09
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 (88)

Utilisation factor for gains for rest of dwelling n2,m

1.00	0.99	0.97	0.91	0.77	0.55	0.37	0.41	0.69	0.94	0.99	1.00
------	------	------	------	------	------	------	------	------	------	------	------

 (89)

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

18.79	19.01	19.34	19.73	20.00	20.10	20.11	20.11	20.07	19.74	19.20	18.75
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (90)

Living area fraction

Living area ÷ (4) = 0.36

 (91)

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

19.23	19.43	19.72	20.07	20.32	20.42	20.43	20.43	20.38	20.08	19.59	19.20
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 (92)

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

19.08	19.28	19.57	19.92	20.17	20.27	20.28	20.28	20.23	19.93	19.44	19.05
-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------

 (93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Utilisation factor for gains, ηm	0.99	0.99	0.97	0.91	0.77	0.56	0.39	0.43	0.70	0.93	0.99	1.00

 (94)

Useful gains, ηmGm, W (94)m x (84)m

498.17	567.43	615.85	632.63	569.46	405.38	267.02	280.23	424.66	507.21	486.69	472.89
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 (95)

Monthly average external temperature from Table U1

4.30	4.90	6.50	8.90	11.70	14.60	16.60	16.40	14.10	10.60	7.10	4.20
------	------	------	------	-------	-------	-------	-------	-------	-------	------	------

 (96)

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

1113.84	1080.73	979.69	815.61	624.87	412.40	267.70	281.50	448.68	688.12	915.66	1107.26
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 (97)

Space heating requirement, kWh/month $0.024 \times [(97)\text{m} - (95)\text{m}] \times (41)\text{m}$

458.06	344.94	270.69	131.75	41.22	0.00	0.00	0.00	0.00	134.60	308.85	471.98
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$\Sigma(98)1...5, 10...12 =$ 2162.09

 (98)

Space heating requirement kWh/m²/year

(98) ÷ (4) = 28.73

 (99)

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

 (201) (202) (202) (204) (205) (206)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Space heating fuel (main system 1), kWh/month	458.06	344.94	270.69	131.75	41.22	0.00	0.00	0.00	0.00	134.60	308.85	471.98
$\Sigma(211)1...5, 10...12 =$	2162.09											

 (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

183.75	161.74	169.37	151.14	147.61	131.18	125.30	138.44	138.49	156.76	166.62	179.09
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$\Sigma(219a)1...12 =$ 1849.49

 (219)

Annual totals

Space heating fuel - main system 1		2162.09	
Water heating fuel		1849.49	
Electricity for pumps, fans and electric keep-hot (Table 4f)			
mechanical ventilation fans - balanced, extract or positive input from outside	175.00		(230a)
central heating pump or water pump within warm air heating unit	30.00		(230c)
Total electricity for the above, kWh/year		205.00	(231)
Electricity for lighting (Appendix L)		339.95	(232)
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =	4556.53	(238)

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2162.09	x	13.19	x 0.01 =	285.18	(240)
Water heating	1849.49	x	13.19	x 0.01 =	243.95	(247)
Pumps and fans	205.00	x	13.19	x 0.01 =	27.04	(249)
Electricity for lighting	339.95	x	13.19	x 0.01 =	44.84	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	601.01	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	2.10	(257)
SAP value	70.72	
SAP rating (section 13)	71	(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	2162.09	x	0.519	=	1122.12	(261)
Water heating	1849.49	x	0.519	=	959.88	(264)
Space and water heating			(261) + (262) + (263) + (264) =		2082.01	(265)
Pumps and fans	205.00	x	0.519	=	106.40	(267)
Electricity for lighting	339.95	x	0.519	=	176.44	(268)
Total CO ₂ , kg/year			(265)...(271) =		2364.84	(272)
Dwelling CO ₂ emission rate			(272) ÷ (4) =		31.43	(273)
EI value					73.65	
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	2162.09	x	3.07	=	6637.61	(261)
Water heating	1849.49	x	3.07	=	5677.93	(264)
Space and water heating			(261) + (262) + (263) + (264) =		12315.54	(265)
Pumps and fans	205.00	x	3.07	=	629.36	(267)
Electricity for lighting	339.95	x	3.07	=	1043.65	(268)
Primary energy kWh/year					13988.55	(272)
Dwelling primary energy rate kWh/m ² /year					185.89	(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	Miss Eleanor Ballinger	Assessor number	9983
Client		Last modified	23/09/2020
Address	3BA2 TF Caversham Road, Reading, RG1		

1. Overall dwelling dimensions

	Area (m ²)		Average storey height (m)		Volume (m ³)	
Lowest occupied	75.50	(1a)	x	2.50	(2a)	= 188.75 (3a)
Total floor area	(1a) + (1b) + (1c) + (1d)...(1n) = 75.50	(4)				
Dwelling volume				(3a) + (3b) + (3c) + (3d)...(3n) =	188.75	(5)

2. Ventilation rate

			m ³ per hour	
Number of chimneys	0	x 40 =	0	(6a)
Number of open flues	0	x 20 =	0	(6b)
Number of intermittent fans	0	x 10 =	0	(7a)
Number of passive vents	0	x 10 =	0	(7b)
Number of flueless gas fires	0	x 40 =	0	(7c)

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

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	3.00	(17)
If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16)	0.15	(18)
Number of sides on which the dwelling is sheltered	2	(19)
Shelter factor	1 - [0.075 x (19)] = 0.85	(20)
Infiltration rate incorporating shelter factor	(18) x (20) = 0.13	(21)

Infiltration rate modified for monthly wind speed:

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

Wind factor (22)m ÷ 4

1.28	1.25	1.23	1.10	1.08	0.95	0.93	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

0.16	0.16	0.16	0.14	0.14	0.12	0.12	0.13	0.14	0.14	0.15	(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 74.80 (23c)

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

0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28	(24a)
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Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25)

0.29	0.29	0.28	0.27	0.26	0.25	0.25	0.24	0.25	0.26	0.27	0.28	(25)
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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			2.12	x 1.00	= 2.12		(26)						
Window			10.41	x 1.15	= 11.92		(27)						
External wall			72.79	x 0.18	= 13.10		(29a)						
Party wall			11.48	x 0.00	= 0.00		(32)						
External wall			23.90	x 0.25	= 5.98		(29a)						
Roof			75.50	x 0.12	= 9.06		(30)						
Total area of external elements ΣA, m ²			184.72				(31)						
Fabric heat loss, W/K = Σ(A × U)					(26)...(30) + (32) =	42.18	(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						23.68	(36)						
Total fabric heat loss					(33) + (36) =	65.86	(37)						
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Ventilation heat loss calculated monthly 0.33 x (25)m x (5)	17.97	17.78	17.58	16.58	16.39	15.39	15.39	15.19	15.79	16.39	16.78	17.18	(38)
Heat transfer coefficient, W/K (37)m + (38)m	83.83	83.64	83.44	82.44	82.25	81.25	81.25	81.05	81.65	82.25	82.64	83.04	
	Average = Σ(39)1...12/12 = 82.39												(39)
Heat loss parameter (HLP), W/m ² K (39)m ÷ (4)	1.11	1.11	1.11	1.09	1.09	1.08	1.08	1.07	1.08	1.09	1.09	1.10	
	Average = Σ(40)1...12/12 = 1.09												(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	2.37	(42)											
Annual average hot water usage in litres per day Vd,average = (25 × N) + 36	90.53	(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)	99.59	95.97	92.34	88.72	85.10	81.48	81.48	85.10	88.72	92.34	95.97	99.59	
	Σ(44)1...12 = 1086.40												(44)
Energy content of hot water used = 4.18 × Vd,m × nm × Tm/3600 kWh/month (see Tables 1b, 1c 1d)	147.68	129.17	133.29	116.20	111.50	96.22	89.16	102.31	103.53	120.66	131.71	143.02	
	Σ(45)1...12 = 1424.45												(45)
Distribution loss 0.15 x (45)m	22.15	19.37	19.99	17.43	16.72	14.43	13.37	15.35	15.53	18.10	19.76	21.45	(46)
Storage volume (litres) including any solar or WWHRs storage within same vessel	180.00												(47)
Water storage loss:													
a) If manufacturer's declared loss factor is known (kWh/day)	1.95												(48)
Temperature factor from Table 2b	0.60												(49)
Energy lost from water storage (kWh/day) (48) x (49)	1.17												(50)
Enter (50) or (54) in (55)	1.17												(55)
Water storage loss calculated for each month (55) x (41)m	36.27	32.76	36.27	35.10	36.27	35.10	36.27	35.10	36.27	35.10	36.27	36.27	(56)
If the vessel contains dedicated solar storage or dedicated WWHRs (56)m x [(47) - Vs] ÷ (47), else (56)													

36.27	32.76	36.27	35.10	36.27	35.10	36.27	36.27	35.10	36.27	35.10	36.27	(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)
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Combi loss for each month from Table 3a, 3b or 3c

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(61)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

183.95	161.93	169.56	151.30	147.77	131.32	125.43	138.58	138.63	156.93	166.81	179.29	(62)
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Solar DHW input calculated using Appendix G or Appendix H

0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	(63)
------	------	------	------	------	------	------	------	------	------	------	------	------

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

183.95	161.93	169.56	151.30	147.77	131.32	125.43	138.58	138.63	156.93	166.81	179.29	
--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--

$$\Sigma(64)1...12 = 1851.50 \quad (64)$$

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

78.12	69.16	73.33	66.72	66.09	60.07	58.66	63.03	62.50	69.13	71.87	76.57	(65)
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5. Internal gains

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Metabolic gains (Table 5)	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	118.60	(66)
Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5	20.13	17.88	14.54	11.01	8.23	6.95	7.51	9.76	13.10	16.63	19.41	20.69	(67)
Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5	209.78	211.96	206.47	194.79	180.05	166.20	156.94	154.76	160.25	171.93	186.67	200.52	(68)
Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	34.86	(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)	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	-94.88	(71)
Water heating gains (Table 5)	105.00	102.91	98.57	92.66	88.83	83.43	78.85	84.72	86.81	92.92	99.82	102.92	(72)
Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m	396.49	394.33	381.16	360.04	338.69	318.16	304.87	310.82	321.74	343.06	367.48	385.71	(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							
South	0.77	x 8.07	x 46.75	x 0.9 x 0.72	x 0.70	= 131.78	(78)						
North	0.77	x 2.34	x 10.63	x 0.9 x 0.72	x 0.70	= 8.69	(74)						
Solar gains in watts Σ(74)m...(82)m	140.47	232.42	303.13	356.04	384.84	376.96	365.48	344.08	321.11	252.55	166.92	121.11	(83)
Total gains - internal and solar (73)m + (83)m	536.96	626.75	684.29	716.08	723.53	695.12	670.35	654.90	642.84	595.61	534.40	506.82	(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	0.94	0.86	0.70	0.52	0.56	0.78	0.95	0.99	1.00	(86)
Mean internal temp of living area T1 (steps 3 to 7 in Table 9c)	19.92	20.09	20.32	20.59	20.82	20.96	20.99	20.99	20.92	20.64	20.22	19.88	(87)
Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C)	19.99	19.99	20.00	20.01	20.01	20.02	20.02	20.02	20.02	20.01	20.01	20.00	(88)
Utilisation factor for gains for rest of dwelling n2,m	0.99	0.99	0.97	0.92	0.82	0.61	0.41	0.44	0.70	0.93	0.99	1.00	(89)
Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c)	18.56	18.81	19.15	19.54	19.84	19.99	20.02	20.02	19.96	19.60	19.01	18.52	(90)
Living area fraction	Living area ÷ (4) =											0.36	(91)
Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2	19.05	19.28	19.57	19.92	20.19	20.34	20.37	20.37	20.31	19.98	19.45	19.01	(92)
Apply adjustment to the mean internal temperature from Table 4e where appropriate	18.90	19.13	19.42	19.77	20.04	20.19	20.22	20.22	20.16	19.83	19.30	18.86	(93)

8. Space heating requirement

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Utilisation factor for gains, ηm	0.99	0.98	0.96	0.92	0.82	0.63	0.44	0.47	0.71	0.92	0.98	0.99	(94)
Useful gains, ηmGm, W (94)m x (84)m	532.67	615.82	659.17	657.16	591.14	436.68	292.13	306.61	459.21	549.55	525.14	503.73	(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, Lm, W [(39)m x [(93)m - (96)m]	1224.03	1189.76	1078.21	896.34	686.32	454.42	294.24	309.69	494.60	758.87	1008.35	1217.55	(97)
Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m	514.37	385.69	311.77	172.21	70.81	0.00	0.00	0.00	0.00	155.73	347.90	531.08	
	Σ(98)1...5, 10...12 =											2489.58	(98)
Space heating requirement kWh/m²/year	(98) ÷ (4) =											32.97	(99)

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

Space heating													
Fraction of space heat from secondary/supplementary system (table 11)												0.00	(201)
Fraction of space heat from main system(s)	1 - (201) =											1.00	(202)
Fraction of space heat from main system 2												0.00	(202)
Fraction of total space heat from main system 1	(202) x [1 - (203)] =											1.00	(204)
Fraction of total space heat from main system 2	(202) x (203) =											0.00	(205)
Efficiency of main system 1 (%)												100.00	(206)
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Space heating fuel (main system 1), kWh/month	514.37	385.69	311.77	172.21	70.81	0.00	0.00	0.00	0.00	155.73	347.90	531.08	
	Σ(211)1...5, 10...12 =											2489.58	(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	183.95	161.93	169.56	151.30	147.77	131.32	125.43	138.58	138.63	156.93	166.81	179.29	
	Σ(219a)1...12 =											1851.50	(219)

Annual totals				
Space heating fuel - main system 1				2489.58
Water heating fuel				1851.50
Electricity for pumps, fans and electric keep-hot (Table 4f)				
mechanical ventilation fans - balanced, extract or positive input from outside		175.58		(230a)
central heating pump or water pump within warm air heating unit		30.00		(230c)
Total electricity for the above, kWh/year				205.58
Electricity for lighting (Appendix L)				355.51
Total delivered energy for all uses	(211)...(221) + (231) + (232)...(237b) =			4902.17

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

	Fuel kWh/year		Fuel price		Fuel cost £/year	
Space heating - main system 1	2489.58	x	13.19	x 0.01 =	328.38	(240)
Water heating	1851.50	x	13.19	x 0.01 =	244.21	(247)
Pumps and fans	205.58	x	13.19	x 0.01 =	27.12	(249)
Electricity for lighting	355.51	x	13.19	x 0.01 =	46.89	(250)
Additional standing charges					0.00	(251)
Total energy cost				(240)...(242) + (245)...(254) =	646.60	(255)

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

Energy cost deflator (Table 12)	0.42	(256)
Energy cost factor (ECF)	2.25	(257)
SAP value	68.56	
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	2489.58	x	0.519	=	1292.09	(261)
Water heating	1851.50	x	0.519	=	960.93	(264)
Space and water heating			(261) + (262) + (263) + (264) =		2253.02	(265)
Pumps and fans	205.58	x	0.519	=	106.70	(267)
Electricity for lighting	355.51	x	0.519	=	184.51	(268)
Total CO ₂ , kg/year				(265)...(271) =	2544.23	(272)
Dwelling CO ₂ emission rate				(272) ÷ (4) =	33.70	(273)
EI value					71.71	
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	2489.58	x	3.07	=	7643.00	(261)
Water heating	1851.50	x	3.07	=	5684.09	(264)
Space and water heating			(261) + (262) + (263) + (264) =		13327.09	(265)
Pumps and fans	205.58	x	3.07	=	631.14	(267)
Electricity for lighting	355.51	x	3.07	=	1091.43	(268)
Primary energy kWh/year					15049.66	(272)

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