

Eaton Court
Energy Statement

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60994 – Eaton Court
Energy Statement

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Revision Table

Rev	Date	Section	Amendment(s)
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Contents

Executive Summary 1

1 Introduction 2

1.1 Software and Modelling Information..... 2

1.2 Development Description 3

2 Sustainability Drivers 4

2.1 National Planning Policy Framework (NPPF) (2021) 4

2.2 The Building Regulations Approved Document Part L2 (2021)..... 4

2.3 Reading Borough Local Plan (2019)..... 5

3 Demand Reduction 6

3.1 Passive Design Measures..... 6

3.2 Active Design Measures..... 6

4 Heating Infrastructure 7

4.1 Future Proofing 7

5 Renewable Energy 8

5.1 Low and Zero Carbon Technologies..... 8

5.2 Renewable Energy Results 8

5.3 Carbon Offsetting..... 8

6 Overheating Risk Analysis 9

6.1 The Good Homes Alliance Early Stage Overheating Risk Tool 9

6.2 National Policy 9

6.3 Measures to mitigate overheating risk and reduce cooling demand 10

6.4 Detailed Overheating Risk Analysis – Assumptions & Results..... 10

6.5 Overheating Results 11

7 Conclusions 12

8 Appendices 13

8.1 Good Homes Alliance (GHA) Early Stage Overheating Risk Tool..... 13

8.2 Overheating Analysis for LHR DSY1, DSY2 & DSY3..... 13

8.3 Low and Zero Carbon Technology Feasibility Study..... 17

8.4 Domestic Part L calculations 0

Executive Summary

This Energy Statement has been prepared by chapmanbdsp on behalf of Venta PropCo 1 Limited (‘the Applicant’) to support the planning application for the proposed development at Eaton Court, 104-112 Oxford Road, Reading.

The proposed development will comprise 120 residential dwellings with plant and refuse areas, reception, cycle storage and access arrangements on the ground floor. There is no provision of commercial floorspace as in the previous planning application.

The energy strategy for this residential development focuses on providing high quality dwellings and amenity spaces that are comfortable throughout the year, but with minimal energy consumption and carbon emissions. The design approach for the scheme follows the energy hierarchy, i.e., ‘demand reduction’, ‘heating infrastructure’, ‘renewable energy’, to achieve the following Reading Borough Local Plan (2019) target for major residential developments:

For residential of ten or more dwellings the development will achieve true carbon neutral development on-site. If this is not achievable, it must achieve a minimum of 35% improvement in regulated emissions over the Target Emissions Rate in the 2013¹ Building Regulations, plus a Section 106 contribution of £1,800 per remaining tonne towards carbon offsetting within the Borough (calculated as £60/tonne over a 30-year period).

Considering the decarbonisation of the grid, SAP 10.2 carbon emission factors have been used for the assessment as the same are being officially accepted by other planning authorities as well. With latest SAP10.2 factors, the development is able to achieve even higher carbon savings.

This report demonstrates the energy and overheating strategy proposed for the proposed development. The design approach targets demand reduction measures first, giving priority to optimisation of building fabric to reduce the need for heating, cooling, and artificial lighting. The objective was to have buildings as energy efficient as possible before considering any mechanical systems and onsite and offsite measures to deliver low carbon performance.

The design of the building, together with the MEP systems, and sustainability features have been optimised to minimise the energy demand. High level of envelope insulation is proposed to ensure heating demand is minimised; whilst solar coating (low g value) on windows has been proposed to reduce the need for cooling. Efficient low energy lighting and mechanical ventilation with high rate of heat recovery are implemented throughout to further reduce energy demand.

A study of district heat networks in proximity of the site was undertaken. The study showed no existing or foreseen networks although the council has a desire to develop such networks in the future.

The development, however, will include a low carbon communal ASHP heating network serving all domestic and amenities areas. The communal ASHP energy network will meet the demand for space heating and domestic hot water. This strategy will provide future resilience to connect to a district heating scheme when one is made available for connection.

Considering the decarbonisation of the grid and the council's target for zero carbon developments, the site's community network will be fed by air source heat pumps (ASHP) to deliver a solution of heat energy to residential units each having HIU units for heating and hot water..

With this design approach, the proposed development achieve a 64%, against Part L 2021 carbon emission target. To meet the zero-carbon target for the remaining carbon emissions will be offset via cash in-lieu contribution.

¹ The current energy strategy is targeting to achieve a minimum of 35% improvement in regulated emissions over the Target Emissions Rate in the **2021** Building Regulations.

The proposed development energy hierarchy

	Carbon Dioxide Emissions for the proposed development (regulated)		
	Tonnes CO ₂ /annum	Savings	% Reduction
Part L 2021 Compliant Building	85.4	-	-
After energy demand reduction	71.1	14.3	17%
After heat network / CHP	71.1	0.0	0%
After renewable energy	30.9	30.9	47%
Total		45.2	64%

	Annual Shortfall (Tonnes CO ₂)	Cumulative Shortfall (Tonnes CO ₂)
Total Target Savings	85.4	-
Shortfall	30.8	924
Cash in-lieu contribution (£)	55,440	-

Table 0-1 Regulated CO₂ savings & cash in lieu contribution for the development.

Detailed dynamic modelling has demonstrated the optimised design can mitigate overheating in line with Part O and CIBSE TM59 via an openable window strategy in the first instance and without the use of blinds. Testing has confirmed that the strategy could mitigate overheating risk sufficiently during a 1 in 3-year heatwave that might occur in the 2020-2040 period (DSY1). This strategy therefore limits the need for cooling and provides a resilient design for the future that doesn't rely on occupant control of blinds to be successful.

	No. Tested	Pass	Fail
Bedrooms	49	49	0
Studios	4	4	0
Living rooms/Kitchens	29	29	0
Total	82	82	0

Table 0-2 Overheating results for the domestic areas

The acoustic report for the development has highlighted the impact of traffic noise on the South façade and night club noise on the North façade. The bedrooms facing facades with acoustic restrictions as well as the dual aspect flats will have windows and balcony doors closed at night and increased provision of ventilation lates with a packaged refrigerant module though MVHR units, where required.

1 Introduction

This Energy Statement has been prepared by chapmanbdsp on behalf of Venta PropCo 1 Limited ('the Applicant') to support the planning application for full planning permission for demolition and residential use redevelopment to provide three buildings comprising residential units, one ground floor unit comprising residential units, plant and refuse areas, reception, cycle storage and access arrangements, and one ground floor unit comprising residential units, along with amenity space, receptions, cycle storage, servicing bay and associated landscaping, plant and refuse areas, and access arrangements

The strategy particularly focuses on carbon emissions reduction in line with the adopted Reading Borough Local Plan guidance. The environmental strategy that describes chapmanbdsp approach to the design process is illustrated in Figure 1-1. This approach targets to first minimise the energy demand and subsequently apply energy efficient systems. As a third step, chapmanbdsp recommends to consider renewables (due to their effectiveness in reducing emissions) prior to relying on other alternatives. The environmental approach adopted is therefore in line with the adopted Reading Borough energy hierarchy (Figure 1-2): fabric energy efficiency, on-site low carbon heating and power.

Energy demand has been minimised by implementing passive envelope design strategies; low emissivity glass, highly insulated windows and walls combined with high level of airtightness. The design also incorporates features which will provide solar shading to reduce the cooling demand of the development. This ensures that the whole-house ventilation with minimum fresh air and with high heat recovery efficiency can meet most of the dwellings' energy needs and reduce the dependency on active cooling for summer comfort.

Subsequently, the energy strategy considers a site wide community heating network for greater efficiency. The study of Reading energy network shows that there are no existing or foreseen district energy network available to connect at this stage of the project.

For future resilience, the adopted centralised low temperature ASHP network strategy will allow for a future connection to a district network when becomes available via heat exchanger and a single capped off pipe connection point. Considering the decarbonisation of the grid and lower emission factors for electricity, the site-wide community network will be fed by a communal air source heat pump network. The reverse cycle heat pump will provide heating and hot water and has been identified as the most appropriate low carbon technology for the proposed scheme.

1.1 Software and Modelling Information

The development has been modelled using an approved software package. Stroma FSAP10 was used to perform the analysis for the domestic assets and Overheating calculations were carried out using IES-VE 2022..

The calculations presented in this report are based on BRE's SAP 10.2 carbon factors.



Figure 1-1 chapmanbdsp Environmental Design Approach

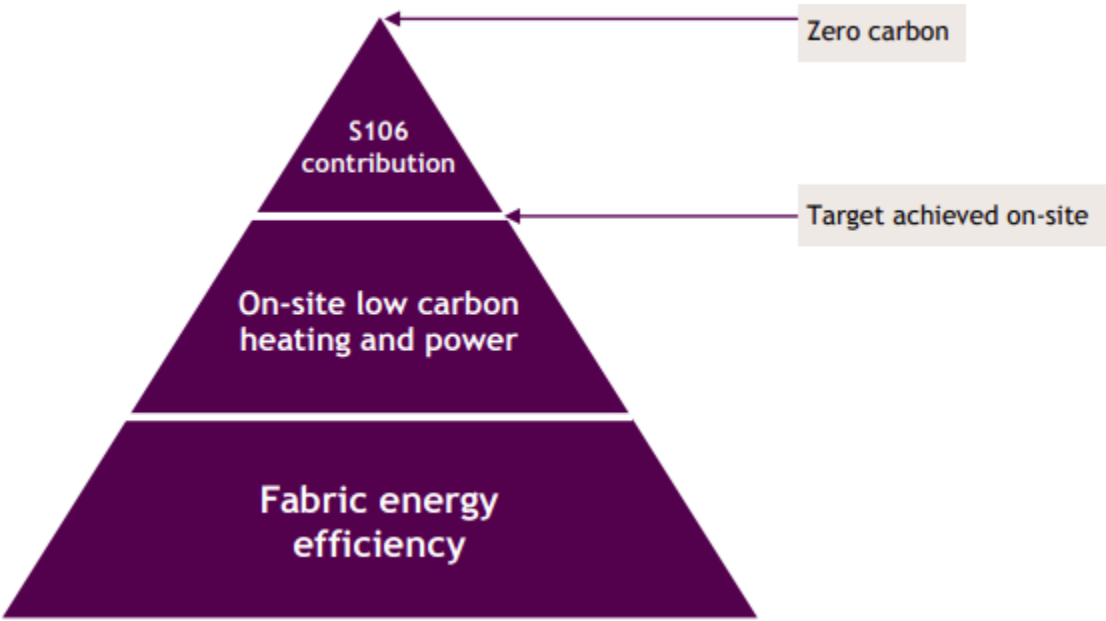


Figure 1-2 Reading Borough energy hierarchy

1.2 Development Description

The development site is located at the junction of Oxford Road and Eaton Place, approximately a 10-minute walk from Reading Train Station.

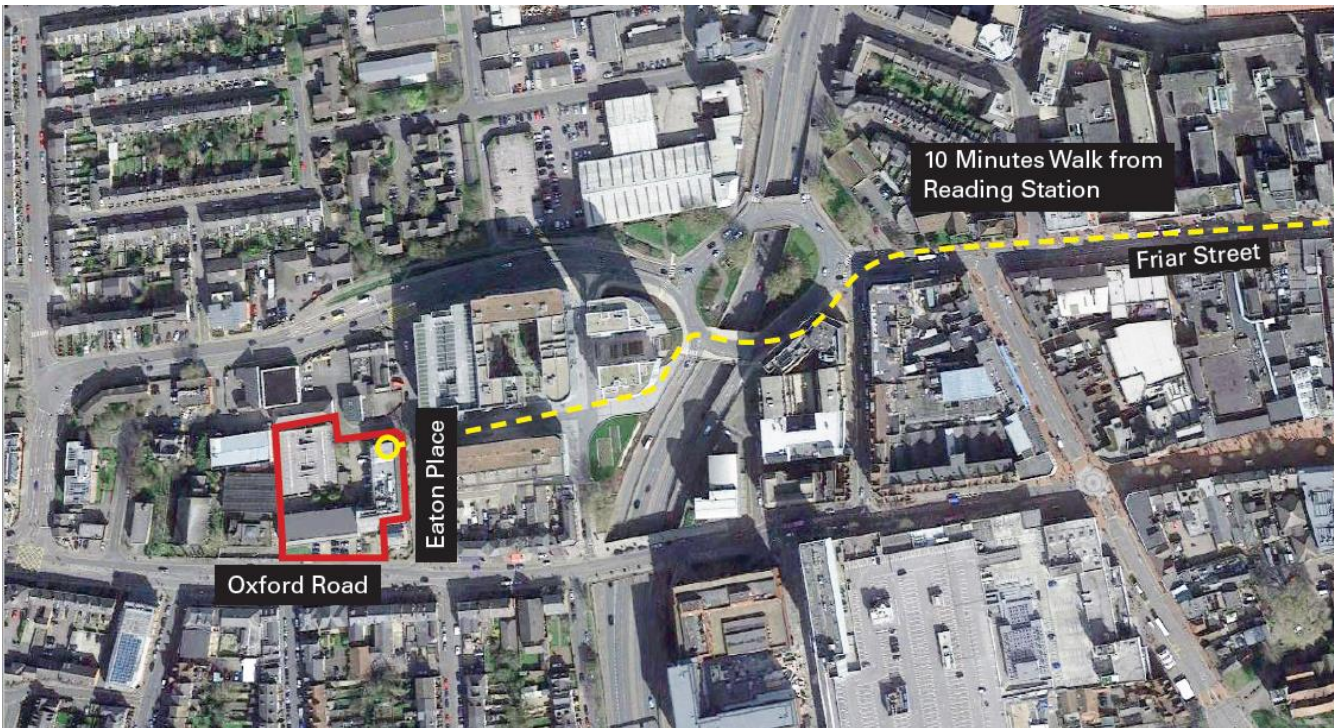


Figure 1-2 Site Location

The proposed development comprises demolition of existing three storey office and provision of new residential blocks providing 120 apartments and residential amenity spaces at ground floor fronting Oxford Road. The proposal constitutes three buildings which will rise between four to six storeys. A total of 14 car parking spaces –6 No. blue badge for residents and 8 No. for Royal Meteorological Society- will be provided on the Site. There is provision for bike storage on the ground floor of each residential block.

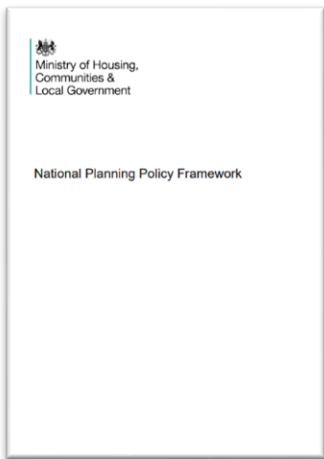
The area schedule for the proposed uses is as below:

Asset	Net Internal Area (m²)
Residential (Apartments & Lobbies)	7,136

2 Sustainability Drivers

This section outlines the most appropriate set of sustainability targets that the project is required to adhere to. The following documents have formed an integral part of developing the energy strategy for Eaton Court development.

2.1 National Planning Policy Framework (NPPF) (2021)



The National Planning Policy Framework (NPPF) sets out the Government's planning policies for England and how these should be applied. It provides a framework within which locally prepared plans for housing and other development can be produced. Planning law requires that applications for planning permission be determined in accordance with the development plan unless material considerations indicate otherwise. The NPPF must be taken into account in preparing the development plan and is a material consideration in planning decisions. Planning policies and decisions must also reflect relevant international obligations and statutory requirements.

The purpose of the NPPF is to contribute to the achievement of sustainable development. At a very high level, the objective of sustainable development can be summarised as meeting the needs of the present without compromising the ability of future generations to meet their own needs. Achieving sustainable development means that the planning system has three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways:

- a) An economic objective – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure.
- b) A social objective – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being.
- 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.

This statement has been developed in line with NPPF and alongside the suite of documents submitted as part of this application fulfils the requirements of the NPPF.

2.2 The Building Regulations Approved Document Part L2 (2021)



Part L of the Building Regulations is the mechanism by which the Government is driving reductions in the regulated CO₂ emissions from new buildings.

Part L 2021 considers 12 sections which must be satisfied as follows:

Section 1: Calculating the target primary energy rate and target emission rate
The first section of the AD L states that “A new building must be built to a minimum standard of total energy performance. This is evaluated by comparing calculations of the performance of the ‘actual building’ against calculations of the performance of a theoretical building, called the ‘notional building’. This must be carried out both at the design stage and when work is complete.”
The energy performance of the notional building is described by the Target Primary Energy Factor (kgCO₂/(m².yr)) and by the Target Emission Rate (kgCO₂/(m².yr)). These two values shall be assessed using a calculation tool in the approved methodology. This can be either Simplified Building Energy Model (SBEM) or any other software approved under the Notice of Approval.

Section 2: Calculating the building primary energy rate and building emission rate

This section states that the same tool used to assess CO₂ emissions shall be used to assess the Target Primary Energy Rate – TPER, the Target Emission Rate – TER, the Building Primary Energy Rate – BPER, the Building Emission Rate – BER.

The above shall be assessed before works start using design values and when the work is complete using figures for the building as built, including any occurred changes and the measured tested air permeability. At both stages the following must be achieved: BER<TER and the BPER<TPER

Section 3: Consideration of high-efficiency alternative systems

The building regulation asks to analyse the technical, environmental and economic feasibility of using high-efficiency alternative systems in the building design, before building work starts on a new non-domestic building. BCB – building control body shall be notified and the output available to be verified. Regulation 25A of Building Regulation 2010 (consideration of high-efficiency alternative systems for new buildings) also applies.

Section 4: Limiting heat gains and losses

The section focuses on U-values which shall be assessed using conventions and method set out in BR443, on Limiting standards for new or replacement elements and Limiting standards for renovated and retained elements which shall not be less than those specified in tables 4.1 & 4.2. These cover continuity of insulation, airtightness in existing buildings, limiting the effects of solar gains in summer, limiting heat losses and gains from building services.

Section 5: Minimum building services efficiencies and controls – general guidance

This section states that for each new fixed building service in a new or existing building, the efficiency shall not be lower than those stated in section 6 tables. Efficiencies shall be based on the appropriate test standard and the test data should be certified by a notified body.

Section 6: System specific guidance

This section sets out minimum standards for specific types of building services. These efficiencies are set out based on documented manufacturers’ test data. Equipment should be designed, specified and installed with the aim of maximising its efficiency when installed.

Section 7: Air permeability and pressure testing

It is mandatory to meet the minimum standard for air permeability in new buildings. This should be supported with evidences, in particular that the test equipment has been calibrated using a UKAS-accredited facility. This shall be reported to the BCB – Building Control Body.

Section 8: Commissioning

Fixed building services must be commissioned with the aim of ensuring that no more fuel and power than reasonable is used and in-use performance is optimised. A commissioning manager shall be appointed for large complex buildings and their competency shall meet the minimum requirement set out under CIBSE Commissioning Code M.

Section 9: Providing information

This section outlines how O+M operations and maintenance instructions log book (compliance with CIBSE TM31 guidance) should be provided to building users/operators.

Section 10: New elements in existing buildings, including extensions

This guidance covers new or replacement thermal elements (opaque envelope, windows, doors, rooflights, etc.), for extending an existing building (i.e., adding a conservatory, extension, porch, etc.).

Section 11: Work to fabric elements in existing buildings

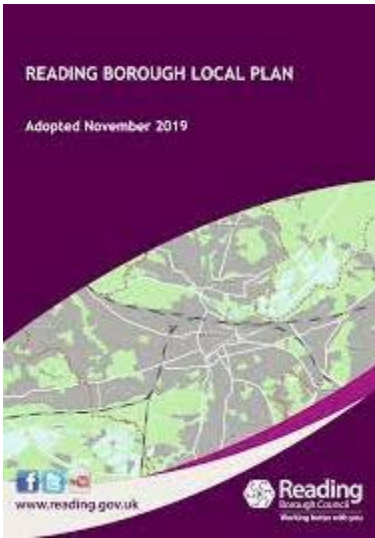
This is a guidance for renovations of existing elements, making a change of use or any other change that constitutes a change to energy status in existing buildings.

Section 12: Consequential improvements

This section refers to existing buildings with a total useful area of over 1000 sqm, and it concerns overall energy efficiency improvement if the proposed work consists of an extension, a provision of fixed building

services for the first time, or an increase in their capacity. Consequential improvements are to ensure that the entire building complies with part L of Building Regulations.

2.3 Reading Borough Local Plan (2019)



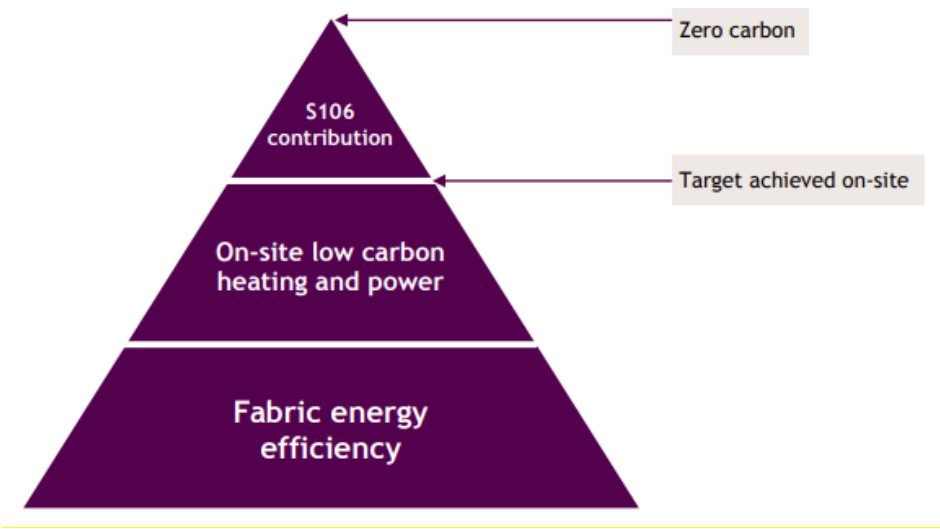
The Local Plan for Reading is the document that contains the policies for how Reading will develop up to 2036, which is the end date of the plan. It identifies the amount of development that will take place, the areas and sites where development is expected to be accommodated, and where it will be restricted, and sets out policies for how planning applications will be decided.

A high-level summary of the policies affecting this energy statement follows next.

CC2: Sustainable Design and Construction

This policy seeks improved sustainability performance of buildings by setting out BREEAM requirements for non-residential developments conversions to residential. It also sets out the general principles of sustainability in new development that applies to both residential and non-residential uses.

Fabric improvements are much more likely to ensure long-term carbon reductions and are generally achieved at lower cost than on-site generation. Therefore, fabric efficiency should be improved in the first instance.



CC3: Adaptation to Climate Change

It identifies measures including building orientation, shading, heating, ventilation, green or brown roofs and walls, planting and surface water run-off to deal with the effects of climate change. This policy will ensure that development within the Borough is resilient in the face of climate change. It is vital that the effects of climate change are considered over the lifetime of a development, especially with regard to its location and design. If they are not, then the long term sustainability and fitness for purpose of the development could be compromised.

CC4: Decentralised Energy

This policy requires developers to consider inclusion of decentralised energy infrastructure, increasing the amount of decentralised energy provision in the Borough. This will help to achieve a shift to sustainable energy consumption and production and covers a wide range of technologies that reduce dependence on a centralised network or grid.

CC5: Waste Minimisation and Storage

This policy requires developers to identify measures to minimise the generation of waste and to handle waste appropriately during the lifetime of a development. It will help to achieve the aims of the Council’s Waste Minimisation Strategy, as well as to comply with national policy.

EN18: Flooding and Drainage

This policy directs development away from areas that are liable to flood. In areas of lower risk, development may move forward if it passes the exception test in the NPPF. It also requires major developments to incorporate Sustainable Drainage Systems (SuDS). This policy will help to protect people and property from flooding.

H5: Housing Standards

This policy outlines standards for new-build housing, including those for sustainable design and construction. All new-build housing must be built to the higher water efficiency standard under the Building Regulations. All major new-build residential should achieve zero carbon homes and all other new-build housing must achieve a minimum 19% improvement over the 2013 Building Regulations target. This policy will help to deliver high-quality new homes and achieve Reading’s emissions targets, as well as mitigate the effects of climate change. Reading’s Climate Change Strategy (Reading Means Business on Climate Change 2013-2020) sets challenging targets for tackling the Borough’s contribution to climate change, and aims to reduce Reading’s carbon footprint by 34% by 2020 in comparison to 2005 levels. One of the Strategy’s strategic principles is that buildings in Reading should be built to high standards of energy efficiency incorporating on-site renewable energy where possible. Given the scale of residential development in Reading up to 2036, achieving the aims of the Climate Change Strategy will not be possible without that development having a minimal impact on carbon emissions. Therefore, the requirement will be that major new housing is built to zero carbon homes standard. Where homes are not designed to be carbon neutral, this will mean as a minimum a 35% improvement in the dwelling emission rate over the 2013 ² Building Regulations plus a contribution of £1,800 per tonne towards carbon offsetting within Reading (calculated as £60 per tonne over a 30 year period). Where it is proposed to meet the zero carbon homes requirement in another way, clear evidence should be provided to demonstrate how it will be achieved at planning application stage.

² However, the current energy strategy is targeting to achieve a minimum of 35% improvement in regulated emissions over the Target Emissions Rate in the **2021** Building Regulations.

3 Demand Reduction

This section presents the reduction in CO₂ emissions achieved through the implementation of passive design and fabric improvements in the first instance.

The design approach for Eaton Court development has targeted demand reduction measures first, giving priority to the optimisation of the building fabric performance to reduce the need for heating, cooling and lighting. The objective was to maximise efficiency as much as possible and avoid reliance on complex active/mechanical systems to deliver a low carbon performance.

The focus was to achieve a low energy building rather than just relying on carbon offsetting technologies. Studies were carried out at early design stages to inform the building envelope in terms of the envelope thermal performance with regards to airtightness and levels of insulation.

3.1 Passive Design Measures

Passive design measures to reduce energy demand incorporated in the project include:

- Optimised glazing ratios, seeking to maximise daylight and useful solar gain, help mitigate overheating risk and minimise heat loss.
- Low Emissivity coated glass and low g-value to limit solar gain, whilst also enabling good light transmittance which contributes to good internal daylight, therefore reducing artificial lighting.
- Efficient double-glazed windows in non-transient spaces including all dwellings; limiting heat loss and providing winter comfort by reducing internal cold surfaces which can result in a radiative cooling effect.
- Glazing systems mounted in the insulation layer of the façade to limit thermal bridging around the frame.
- Openable windows without permanent restrictors to enable effective natural ventilation and a passive cooling strategy.
- High levels of thermal insulation for opaque elements, reducing heat loss.
- Thermal bridging mitigated wherever possible to limit heat loss.
- High level of airtightness, reducing heat loss and mitigating drafts
- External solar shading from recessed windows and balcony doors helping to reduce unwanted solar gains.
- External solar shading through the slab level projections (balconies)
- Maximised passive ventilation potential in residential.

3.1.1 Building Fabric

The proposed and target fabric performance for the proposed development areas of the development is presented in the table below.

Parameters	Units	Proposed development	
		Part L 2021 Requirement	Proposed Targets
External walls	W/m ² K	0.18	0.15
Party walls between dwellings and corridors	-	Either fully filled cavity with sealed edges or of solid construction and heated corridors	
Exposed & ground floors	W/m ² K	0.13	0.12

Parameters		Units	Proposed development	
			Part L 2021 Requirement	Proposed Targets
Exposed roof		W/m ² K	0.11	0.11
Balcony build-up		W/m ² K	0.13	0.12
Dwellings floor to commercial		W/m ² K	0.2	0.12
Window (glazing & frame)	U-value	W/m ² K	1.2	1.2
	g-value	-	0.63	0.35 0.28 for kitchen/living spaces balcony doors
	Light transmittance	-	-	70% and 65% kitchen/living
Thermal bridging average (y-value)				0.05
Air permeability rate		m ³ /m ² .hr @50Pa	5	2

Table 3-1 – Fabric performance of the proposed development development

3.2 Active Design Measures

Following from the passive measures that deal with fabric losses and gains balance, energy efficiency (active) measures have also been proposed to further reduce energy demand. All dwellings will be provided with a high efficiency whole-house mechanical ventilation with minimum fresh air and very high heat recovery rate. The following is proposed:

- Low energy lighting throughout including the use of LEDs
- Mechanical ventilation with heat recovery (MVHR) providing constant fresh air whilst preheating incoming air with outgoing warm air, reducing the need of space heating.
- Metering and sub-metering to monitor energy use by type and by dwelling, enabling energy management and occupant behavioural changes.

Artificial lighting uses low-energy light fittings and efficient lighting controls that include presence/absence detection and daylight linked dimming, where appropriate. Domestic hot water (DHW) will be supplied to each apartment via Heat Interface Unit (HIU) from the main central system with supplementary electric immersion as a boost controlled on a timer to raise the temperature.

4 Heating Infrastructure

A study of district heat networks in proximity of the site was undertaken. The study showed no existing or foreseen networks although the council has a desire to develop such networks in the future.

Eaton Court development will be provided with a communal ASHP heat network served by a central energy centre which has the following advantages:

- Future connection to area-wide district heating scheme for energy sharing and network expansion. Service sleeves will be provided for future connections.
- Future installation of advanced technology for demand side response and integration of smart technologies.

4.1 Future Proofing

The proposal for this development includes an energy centre with community heating network which could be connected to zero carbon heat generators or district network in the future.

2050 is 30 years away, during which time the energy landscape could evolve significantly, especially when the rates of change are considered.

The Government's 'Clean Growth Strategy' report, produced to support 'Climate Change Act' commitments, declares that technological breakthroughs that will help deliver the carbon budgets and targets cannot be exactly predicted. The 'pathways' illustrated in the strategy are based on current technologies. For buildings, the proposals include the following:

- Virtually zero carbon electricity grid by 2050
- Smart electricity grids
- Low carbon sources of heating through district heating
- Hydrogen fuel for heating

Advancements in existing and emerging technologies are accelerating, resulting in even further synergies and discoveries. The rate, as well as the nature and magnitude of change are expected to increase. Building level technologies which will be available to facilitate zero carbon operation cannot be exactly predicted now.

However, it is likely that when the Government achieves these targets, then this development will be plugged into a zero-carbon infrastructure. It is envisaged that any residual carbon will be mitigated by the building level technology available at that time.

5 Renewable Energy

At an early stage, a holistic review of low and zero carbon technologies was undertaken factoring in a wide range of factors that influence their successful design and operation. A summary of the low and zero carbon matrix that can be found in Appendix 8.2 which considers the following:

- Current and future planning policies/aspirations
- Opportunities of the site and energy demand/profile of the development
- Practical implementation considerations
- Installation and maintenance issues
- Implications for internal arrangement and space allocation, infrastructure and site layout
- Public acceptability
- Environmental and visual impact
- Deliverability
- Security and availability of fuel supply
- Capital and life cycle costs, payback and grants
- Carbon contribution and cost per CO₂ saving
- Interactions of the technologies with one another.

5.1 Low and Zero Carbon Technologies

Air Source Heat Pump (ASHP)

A feasibility study for various LZC technologies established that considering the decarbonisation of the grid, SAP10.2 factors and emerging technologies, a reverse cycle air source heat pump (ASHP) would be the most appropriate low carbon technology for the development.

The feasibility table is appended in Appendix 8.3.

5.2 Renewable Energy Results

Communal ASHP is proposed for the Eaton Court development energy strategy to provide a site-wide carbon emission reduction of 54.6 tonnes of CO₂. The strategy is based on a centralised servicing concept of heating via Air Source Heat Pumps (ASHP).

	Domestic
Ventilation system	Balanced with heat recovery (MVHR) SFP 0.6W/l/s Efficiency 90%
Heating	Communal Air Source Heat Pump COP 2.11
Domestic Hot Water	
Cooling	MVHR with refrigerant module
Lighting luminaire (lm/circuit watt)	N/A
Occupancy control	N/A
Low energy lights %	100%

Table 5-1 below shows the expected carbon emissions at the ‘Renewable Energy’ stage for the proposed development.

	Regulated carbon dioxide savings for the proposed development	
	(Tonnes CO ₂ per annum)	(%)
Savings from demand reduction	14.3	17%
Savings from CHP	0	0%
Savings from renewable energy	40.3	47%
Cumulative on-site savings	54.6	64%

Table 5-1 Proposed development CO₂ emissions after the green stage of the energy hierarchy

5.3 Carbon Offsetting

For residential developments of ten or more dwellings, the Reading Borough Local Plan (2019) requires the development to achieve true carbon neutral development on-site. If this is not achievable, it must achieve a minimum of 35% improvement in regulated emissions over the Target Emissions Rate in the 2013 Building Regulations, plus a Section 106 contribution of £1,800 per remaining tonne towards carbon offsetting within the Borough (calculated as £60/tonne over a 30-year period).

	Annual Shortfall (Tonnes CO ₂)	Cumulative Shortfall (Tonnes CO ₂)
Total Target Savings	85.4	-
Shortfall	30.8	924
Cash in-lieu contribution (£)	55,440	-

Following the implementation of the energy hierarchy, the estimated carbon shortfall for residential is 30.8 tCO₂/year.

The estimated carbon offset payment for this development is £55,440.

6 Overheating Risk Analysis

6.1 The Good Homes Alliance Early Stage Overheating Risk Tool

The Good Homes Alliance (GHA) Early Stage Overheating Risk Tool was used early in the design process to identify potential overheating risk. The completed tool can be found in section **Error! Reference source not found.** It concluded that a further detailed assessment was required for the Site.

6.2 National Policy

6.2.1 Approved Document O: Overheating Mitigation (2022)



ADO took effect on 15 June 2022 for use in England and applies to all new residential developments, i.e., dwellings (houses and flats), school or similar establishments where people sleep on the premises, residential colleges, hall of residences and other student accommodation, and living accommodation for children aged 5 years and older.

To demonstrate compliance using the dynamic thermal modelling method, all of the following guidance should be followed:

- 1. CIBSE’s TM59 methodology for predicting overheating risk.
- 2. Additional limits on the use of CIBSE’s TM59 methodology for the openings’ schedule as per Table 6.1.
- 3. Acceptable strategies for reducing overheating risk, such as fixed shading devices, glazing design, building design and shading provided by adjacent permanent buildings, structures or landscaping.

Although internal blinds and curtains provide some reduction in solar gains, they should not be taken into account when considering whether

requirement O1 has been met. Foliage, such as tree cover, can provide some reduction in solar gains. However, it should not be taken into account when considering whether requirement O1 has been met.

Day-time: 8 to 23 hrs	
I.	Start to open when the internal temperature exceeds 22 C.
II.	Be fully open when the internal temperature exceeds 26 C.
III.	Start to close when the internal temperature falls below 26 C.
IV.	Be fully closed when the internal temperature falls below 22 C.

Night-time: 23 to 8 hrs	
a)	At night (11pm to 8am), openings should be modelled as fully open if both of the following apply:
I.	The opening is on the first floor or above and not easily accessible.
II.	The internal temperature exceeds 23°C at 11pm.
b)	When a ground floor or easily accessible room is unoccupied, both of the following apply:
I.	In the day, windows, patio doors and balcony doors should be modelled as open, if this can be done securely, following the guidance in paragraph 3.7 below.
II.	At night, windows, patio doors and balcony doors should be modelled as closed.
c)	An entrance door should be included, which should be shut all the time.

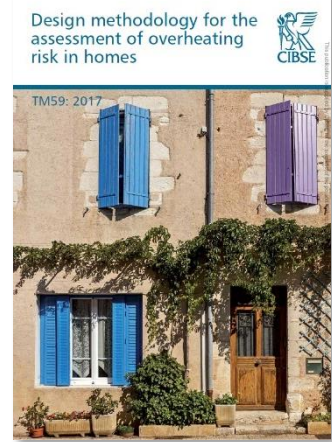
Table 6-1 Schedules for window opening when using dynamic thermal modelling to satisfy ADO.

Requirement O1 is met in a new residential building if the building’s overheating mitigation strategy for use by occupants takes account of all of the following:

- 1. Noise at night: Windows are likely to be closed during sleeping hours if noise within bedrooms exceeds the following limits:
 - a. 40dB LAeq,T, averaged over 8 hours (between 11pm and 7am).

- b. 55dB LAFmax, more than 10 times a night (between 11pm and 7am).
- 2. Pollution: Buildings located near to significant local pollution sources should be designed to minimise the intake of external air pollutants
- 3. Security: When determining the free area available for ventilation during sleeping hours, only the proportion of openings that can be opened securely should be considered to provide useful ventilation. This particularly applies in the following locations, where openings may be vulnerable to intrusion by a casual or opportunistic burglar.
- 4. Protection from falling: Openings which are intended to be open for long periods to reduce overheating risk might pose a higher risk of falls from height. Only the proportion of openings which can be opened with a very low risk of occupants falling from height should be considered to form part of the overheating mitigation strategy.
- 5. Protection from entrapment.

6.2.2 CIBSE TM59: Design Methodology for the Assessment of Overheating Risk in Homes (2017)



Residential areas of the proposed development are assessed against the CIBSE TM59: Design Methodology for the Assessment of Overheating Risk in Homes criteria. This uses an adaptive approach in which occupants’ thermal comfort is affected by their experience over the previous days.

An additional criterion is assessed at night. This criterion assesses whether night-time temperatures will be greater than 26°C – the temperature above which sleep disruption is likely to occur.

	Assessment Criteria	Target / acceptable deviation
Criterion A	Living rooms, kitchens, bedrooms & studios Frequency of occupied hours when ΔT ≥ 1 °C (Internal temperature vs external running mean)	3% of occupied hours during May -September, i.e. <110 hrs for bedrooms & studios <59 hrs for living rooms
Criterion B	Bedrooms & studios: Frequency of occupied hours when operative temperature ≥ 26 °C	1% of annual hours from 10pm to 7am, i.e. <32 hrs for bedrooms & studios

Table 6-2 CIBSE TM59 assessment criterion

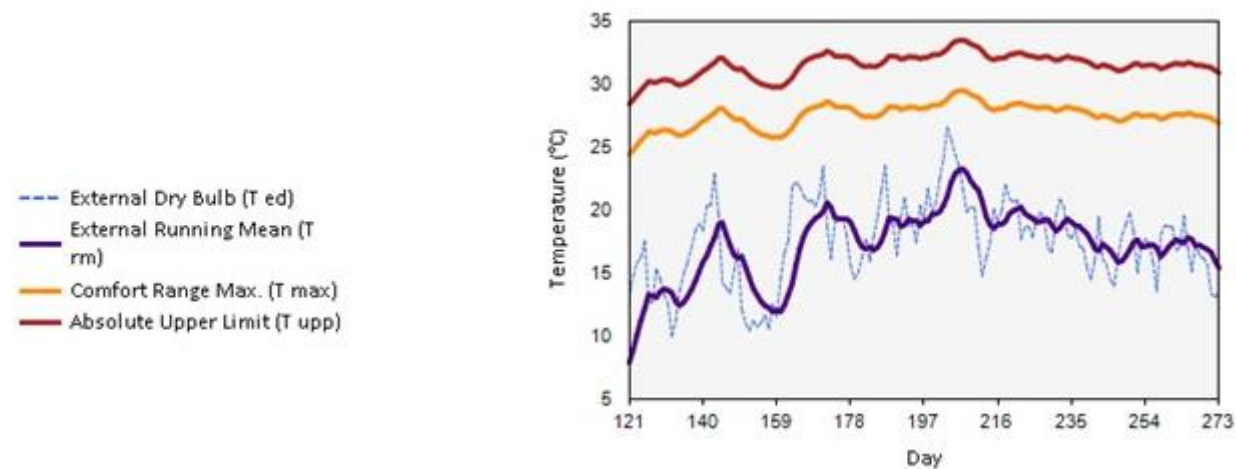


Figure 6-1 Adaptive Summer temperature example for London DSY

6.3 Measures to mitigate overheating risk and reduce cooling demand

As part of the drive to mitigate overheating and reduce cooling demand, the design team prioritise passive measures first in order develop a successful overheating mitigation strategy.

The proposed approach is summarised in the following table.

Overheating mitigation strategy - Steps	Proposed development
Minimise internal heat generation through energy-efficient design	- Low energy lighting specified throughout with the inclusion of presence detection, where feasible. - Availability of natural light is maximised to discourage the use of artificial lighting. - Energy Efficiency appliances are proposed along with guidance to occupants via the Building/Home User Guides - Communal pipework will be insulated to mitigate distribution losses
Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs.	- Building fabric has high levels of insulation and good levels of airtightness limiting heat ingress. - Optimised glazing areas to limit solar gain. - Recessed glazing to provide solar protection. - Solar control glazing to limit solar gain. - Measures have been implemented without the use of blinds therefore providing a resilient solution that doesn't rely on human intervention to be successful.
Passive ventilation	- Natural daytime and night-time ventilation enabled via openable windows and balcony doors. The window control assumptions are listed in Table 6-1. - High thermal mass of the slab and façade structure stabilises daytime internal temperature fluctuations.
Mechanical ventilation	Standard Part F ventilation rate provided by a mechanical ventilation with heat recovery system under summer bypass

Overheating mitigation strategy - Steps	Proposed development
	mode. Enhanced ventilation and compliance cooling is provided to rooms where noise restrictions apply and/or rooms with high solar gains due to orientation.

Table 6-3 The overheating mitigation strategy.

The well insulated envelope combined with openable windows provide the potential for very effective daytime and night-time natural ventilation with high level of occupant air flow control. This will be complemented by a combination of MVHR and packaged refrigerant module. All systems within the dwellings will be compliant with Building Regulations Part F and CIBSE guidelines. Residential ventilation will be provided beyond Building Regulations standards in a number of dwellings in order to provide adequate ventilation in order to mitigate overheating.

The orientation of the building, façade details and surrounding context contributes to provide self-shading and minimise direct solar radiation. Detailed overheating analysis has been carried out using IES-VE 2022 for the residential units and is detailed in the following sections.

6.4 Detailed Overheating Risk Analysis – Assumptions & Results

In line with the initial outcome of The Good Homes Alliance Early Stage Overheating Risk Tool and in line with the national policy, detailed overheating analysis was undertaken for the proposed Site. For the purpose of the study, the following assessment methods were followed:

- Residential areas – Approved Document Part O: Overheating (2022) and in line with CIBSE TM59 Design methodology for the assessment of overheating risk in homes (2017)

Overheating assessments have been completed for a representative sample of room spaces across the site. Overheating analysis has been carried out using dynamic simulation modelling software as modelled in IES-VE version 2022. This software tool is fully compliant with the CIBSE Applications Manual 11: Building Energy and Environment Modelling.

The following assumptions have been made in the detailed overheating analysis:

- The building orientation is largely fixed by the constraints of the site and its proximity to the nearby road network. The surrounding buildings have been modelled to consider the over-shading from the neighbouring buildings. Trees are conventionally excluded from the dynamic thermal model.
- The model has been built to reflect the proposed layouts of high risk zones (kitchen, living and dining (KDL) zones, bedrooms and studios, particularly those with south and west exposure).
- The weather file that has been used for the overheating assessment is CIBSE London Heathrow DSY1 for 2020s, high emissions, 50% percentile scenario.
- Occupancy patterns and internal gains for the domestic areas are prescribed by the CIBSE TM59 methodology.
- From the noise assessment undertaken for the site, it is understood that there may be road traffic noise to the south façade of Building 1 as well as night club noise to the west facade of Building 3. Therefore, on these facades, closed windows/ balcony doors for bedrooms have been assumed during the night as a minimum Part O requirement. The minimum (Part F) mechanical ventilation is provided to all units, However, the dwellings affected by the noise and dual aspect dwellings are provided with enhanced mechanical background ventilation rates with a refrigerant module MVHR.

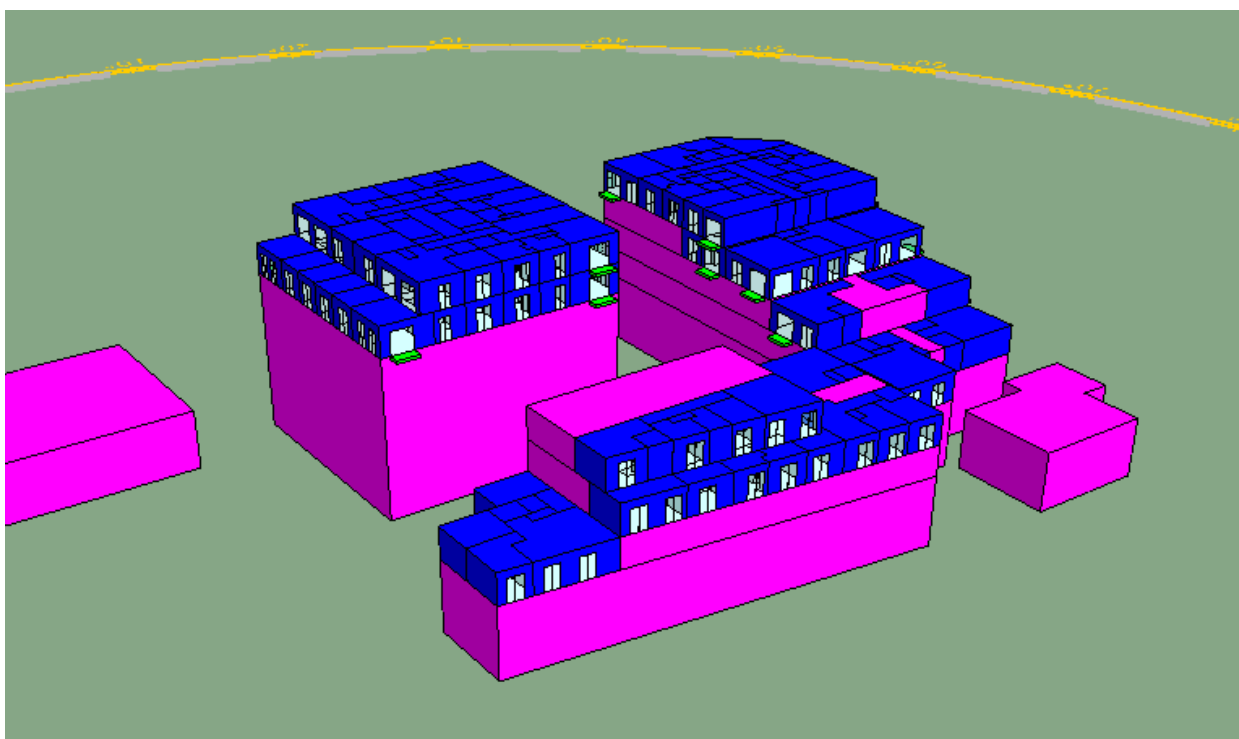


Figure 6-2 Model image of Eaton Court development

6.5 Overheating Results

The results in Table 6-5 show that all rooms meet the recommended level of summer comfort for DSY1.

	No. Tested	Pass	Fail
Bedrooms	49	49	0
Studios	4	4	0
Living rooms/Kitchens	29	29	0
Total	82	82	0

Table 6-5 Overheating results for the residential areas

The acoustic report for the development has highlighted the impact of traffic noise on the South façade of Building 1 and night club noise on the West façade of Building 3. These rooms will have windows and balcony doors closed at night and increased provision of ventilation later with a packaged refrigerant module though MVHR units, where required.

An initial overheating study that was conducted taking into account the acoustic restrictions and assuming the minimum MVHR ventilation rates (Part F) showed that a percentage of bedrooms and kitchens fail to pass overheating (see Appendix 8.2).

The full results of the overheating analysis can be found in Appendix 8.2.

7 Conclusions

The energy strategy for Eaton Court targeted demand reduction measures first, giving priority to optimisation of building fabric to reduce the need for heating, cooling, and artificial lighting. The objective was to have buildings as energy efficient as possible without relying on overly complicated systems or technologies to deliver low carbon performance. The aim was to achieve a low-energy building without relying on carbon offsetting technologies only.

The design team has put considerable effort in optimising the fabric of the building envelope and in implementing other energy demand reduction measures so that the provision of a communal heating system provides significant reduction in overall carbon emissions. A Communal ASHP system for heating and hot water supply has been proposed to offset carbon emissions in order to meet and exceed the minimum requirements set out in the Reading Plan. To meet the zero-carbon target for the development the remaining carbon emissions will be offset via offsite measure and secured by a cash in lieu contribution.

The proposed development achieve an improvement of 64% over the Part L 2021, exceeding the minimum policy criteria of 35% improvements in regulated carbon emissions over the Part L 2021 target.

Detailed dynamic modelling has demonstrated the optimised design can mitigate overheating in line with Part O and CIBSE TM59 via an openable window strategy in the first instance and without the use of blinds. Testing has confirmed that the strategy could mitigate overheating risk sufficiently during a 1 in 3-year heatwave that might occur in the 2020-2040 period (DSY1). This strategy therefore limits the need for cooling and provides a resilient design for the future that doesn't rely on occupant control of blinds to be successful.

The acoustic report for the development has highlighted the impact of traffic noise on the South façade of Building 1 and night club noise on the West façade of Building 3. The bedrooms facing facades with acoustic restrictions as well as the dual aspect flats will have windows and balcony doors closed at night and increased provision of ventilation later with a packaged refrigerant module though MVHR units, where required.

8 Appendices

8.1 Good Homes Alliance (GHA) Early Stage Overheating Risk Tool

EARLY STAGE OVERHEATING RISK TOOL

Version 1.0, July 2019

This tool provides guidance on how to assess overheating risk in residential schemes at the early stages of design. It is specifically a pre-detail design assessment intended to help identify factors that could contribute to or mitigate the likelihood of overheating. The questions can be answered for an overall scheme or for individual units. Score zero wherever the question does not apply. Additional information is provided in the accompanying guidance, with examples of scoring and advice on next steps. Find out more information and download accompanying guidance at goodhomes.org.uk/overheating-in-new-homes

KEY FACTORS INCREASING THE LIKELIHOOD OF OVERHEATING

KEY FACTORS REDUCING THE LIKELIHOOD OF OVERHEATING

Geographical and local context

#1 Where is the scheme in the UK?
See guidance for map

South east	4
Northern England, Scotland & NI	0
Rest of England and Wales	2

4

#2 Is the site likely to see an Urban Heat Island effect?
See guidance for details

Central London (see guidance)	3
Grtr London, Manchester, Bham	2
Other cities, towns & dense sub-urban areas	1

3

Site characteristics

#3 Does the site have barriers to windows opening?
- Noise/Acoustic risks
- Poor air quality/smells e.g. near factory or car park or very busy road
- Security risks/crime
- Adjacent to heat rejection plant

Day - reasons to keep all windows closed	8
Day - barriers some of the time, or for some windows e.g. on quiet side	4
Night - reasons to keep all windows closed	8
Night - bedroom windows OK to open, but other windows are likely to stay closed	4

8

#8 Do the site surroundings feature significant blue/green infrastructure?
Proximity to green spaces and large water bodies has beneficial effects on local temperatures; as guidance, this would require at least 50% of surroundings within a 100m radius to be blue/green, or a rural context

1

#9 Are immediate surrounding surfaces in majority pale in colour, or blue/green?
Lighter surfaces reflect more heat and absorb less so their temperatures remain lower; consider horizontal and vertical surfaces within 10m of the scheme

1

#10 Does the site have existing tall trees or buildings that will shade solar-exposed glazed areas?
Shading onto east, south and west facing areas can reduce solar gains, but may also reduce daylight levels

1

Scheme characteristics and dwelling design

#4 Are the dwellings flats?
Flats often combine a number of factors contributing to overheating risk e.g. dwelling size, heat gains from surrounding areas; other dense and enclosed dwellings may be similarly affected - see guidance for examples

3

3

#5 Does the scheme have community heating?
i.e. with hot pipework operating during summer, especially in internal areas, leading to heat gains and higher temperatures

3

-

#11 Do dwellings have high exposed thermal mass AND a means for secure and quiet night ventilation?
Thermal mass can help slow down temperature rises, but it can also cause properties to be slower to cool, so needs to be used with care - see guidance

1

-

#12 Do floor-to-ceiling heights allow ceiling fans, now or in the future?
Higher ceilings increase stratification and air movement, and offer the potential for ceiling fans

>2.8m and fan installed	2
> 2.8m	1

1

Solar heat gains and ventilation

#6 What is the estimated average glazing ratio for the dwellings?
(as a proportion of the facade on solar-exposed areas i.e. orientations facing east, south, west, and anything in between). Higher proportions of glazing allow higher heat gains into the space

>65%	12
>50%	7
>35%	4

7

#7 Are the dwellings single aspect?
Single aspect dwellings have all openings on the same facade. This reduces the potential for ventilation

Single aspect	3
Dual aspect	0

3

#13 Is there useful external shading?
Shading should apply to solar exposed (E/S/W) glazing. It may include shading devices, balconies above, facade articulation etc. See guidance on "full" and "part". Scoring depends on glazing proportions as per #6

	Full	Part
>65%	6	3
>50%	4	2
>35%	2	1

2

#14 Do windows & openings support effective ventilation?
Larger, effective and secure openings will help dissipate heat - see guidance

	Openings compared to Part F purge rates		
	= Part F	+50%	+100%
Single aspect	minimum required	3	4
Dual aspect	minimum required	2	3

3

TOTAL SCORE 29 = Sum of contributing factors: 36 minus Sum of mitigating factors: 7

High 12

Medium 8

Low

score >12:
Incorporate design changes to reduce risk factors and increase mitigation factors
AND Carry out a detailed assessment (e.g. dynamic modelling against CIBSE TM59)

score between 8 and 12:
Seek design changes to reduce risk factors and/or increase mitigation factors
AND Carry out a detailed assessment (e.g. dynamic modelling against CIBSE TM59)

score <8:
Ensure the mitigating measures are retained, and that risk factors do not increase (e.g. in planning conditions)

8.2 Overheating Analysis for LHR DSY1, DSY2 & DSY3

Figure 8-1 IES model, detailed views of assessed typical floors

13

Apartment No.	Room Reference	Level	Max. % Exceedable Hours	Criterion 1: Hours Exceeding Comfort Range	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
FLAT1_FL02_BLD1	BD1	2	3	0.4	32	32	Pass
	BD2	2	3	1	32	17	Pass
	BD3	2	3	1	32	21	Pass
	KDLp6	2	3	1.9	-	-	Pass
FLAT2_FL03_BLD1	BD	3	3	1.5	32	31	Pass
	KDL-1bed	3	3	2.5	-	-	Pass
FLAT3_FL03_BLD1	BD	3	3	1.6	32	29	Pass
	BS	3	3	1.6	32	26	Pass
	KDL-2bed	3	3	2.4	-	-	Pass
FLAT4_FL03_BLD1	BD	3	3	1.3	32	26	Pass
	BS	3	3	1.7	32	32	Pass
	KDL-2bed	3	3	2.4	-	-	Pass
FLAT6_FL03_BLD1	BD	3	3	1.3	32	16	Pass
	KDL-1bed	3	3	2.5	-	-	Pass
Studio_FL03_BLD1	SD	3	3	1.2	32	16	Pass
Studio1_FL03_BLD1	SD	3	3	1.5	32	16	Pass
Studio2_FL03_BLD1	SD	3	3	1.2	32	16	Pass
FLAT2_FL04_BLD1	BD1	4	3	1.1	32	31	Pass
	BD2	4	3	1.4	32	27	Pass
	BS	4	3	1.6	32	28	Pass
	KDLp5	4	3	3	-	-	Pass
FLAT1_FL02_BLD2	BD1	2	3	1.7	32	16	Pass
	BD2	2	3	1.7	32	16	Pass
	BS	2	3	1.8	32	19	Pass
	KDL-3bed	2	3	2.9	-	-	Pass
Studio1_FL02_BLD2	SD	2	3	1.2	16	16	Pass
FLAT3_FL04_BLD2	BD1	4	3	1.8	32	15	Pass
	BD2	4	3	1.4	32	13	Pass
	KDL-2bed	4	3	3	-	-	Pass
FLAT9_FL04_BLD2	BD	4	3	1.7	32	16	Pass
	KDL-1bed	4	3	2.6	-	-	Pass
FLAT8_FL04_BLD2	BD1	4	3	1.7	32	15	Pass
	BD2	4	3	1.3	32	13	Pass
	KDL-2bed	4	3	2.8	-	-	Pass
FLAT5_FL05_BLD2	BD	5	3	1.5	32	16	Pass
	BS	5	3	1.9	32	13	Pass
	KDL-2bed	5	3	3.0	-	-	Pass
FLAT3_FL05_BLD2	BD	5	3	1.3	32	15	Pass
	KDL-1bed	5	3	2.9	-	-	Pass
FLAT6_FL05_BLD2	BD	5	3	1.3	32	16	Pass
	KDL-1bed	5	3	2.8	-	-	Pass
FLAT7_FL05_BLD2	BD	5	3	1.3	32	14	Pass
	BS	5	3	1.6	32	13	Pass
	KDL-2bed	5	3	2.6	-	-	Pass
FLAT8_FL05_BLD2	BD	5	3	1.3	32	17	Pass
	KDL-1bed	5	3	2.7	32	-	Pass
FLAT1_FL05_BLD3	BD1	5	3	1.5	32	14	Pass
	BS	5	3	1.7	32	22	Pass
	KDL-2bed	5	3	2.8	-	-	Pass
FLAT2_FL05_BLD3	BD	5	3	1.3	32	20	Pass
	KDL-1bed	5	3	2	-	-	Pass
FLAT3_FL05_BLD3	BD	5	3	1.3	32	20	Pass
	KDL-1bed	5	3	2.3	-	-	Pass
FLAT4_FL05_BLD3	BD2	5	3	1.3	32	14	Pass
	BS	5	3	1.5	32	22	Pass
	KDL-2bed	5	3	2.7	-	-	Pass
FLAT5_FL05_BLD3	BD	5	3	1.2	32	14	Pass
	BS	5	3	1.6	32	22	Pass
	KDL-2bed	5	3	2.9	-	-	Pass
FLAT6_FL05_BLD3	BD	5	3	1.4	32	17	Pass
	KDL-1bed	5	3	1.8	-	-	Pass
FLAT7_FL05_BLD3	BD	5	3	1.4	32	19	Pass
	KDL-1bed	5	3	2.4	-	-	Pass
FLAT8_FL05_BLD3	BD	5	3	1.6	32	14	Pass
	BS	5	3	1.6	32	22	Pass
	KDL-2bed	5	3	2.7	-	-	Pass
FLAT1_FL06_BLD3	BD1	6	3	1.6	32	13	Pass
	BD2	6	3	1.5	32	32	Pass

Apartment No.	Room Reference	Level	Max. % Exceedable Hours	Criterion 1: Hours Exceeding Comfort Range	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
FLAT4_FL06_BLD3	KDL-2bed	6	3	3	-	-	Pass
	BD1	6	3	1.3	32	20	Pass
	BD2	6	3	1.5	32	13	Pass
	KDL-2bed	6	3	2.9	-	-	Pass
FLAT5_FL06_BLD3	BD	6	3	1.2	32	14	Pass
	BS	6	3	1.6	32	22	Pass
	KDL-2bed	6	3	2.9	-	-	Pass
FLAT6_FL06_BLD3	BD	6	3	1.4	32	16	Pass
	KDL-1bed	6	3	2.6	-	-	Pass
FLAT7_FL06_BLD3	BD	6	3	1.4	32	16	Pass
	KDL-1bed	6	3	2.8	-	-	Pass
FLAT8_FL06_BLD3	BD	6	3	1.5	32	14	Pass
	BS	6	3	1.6	32	22	Pass
	KDL-2bed	6	3	2.7	-	-	Pass

Table 8-1 Overheating results for the Bedrooms, Living areas and Kitchens for DSY1 London Heathrow Airport

Apartment No.	Room Reference	Level	Max. % Exceedable Hours	Criterion 1: Hours Exceeding Comfort Range	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
FLAT1_FL02_BLD1	BD1	2	3	1.4	32	67	Fail
	BD2	2	3	1.7	32	32	Pass
	BD3	2	3	1.7	32	39	Fail
	KDLp6	2	3	3.3	-	-	Fail
FLAT2_FL03_BLD1	BD	3	3	2.3	32	67	Fail
	KDL-1bed	3	3	3.7	-	-	Fail
FLAT3_FL03_BLD1	BD	3	3	2.3	32	62	Fail
	BS	3	3	2.3	32	60	Fail
	KDL-2bed	3	3	3.6	-	-	Fail
FLAT4_FL03_BLD1	BD	3	3	2.1	32	59	Fail
	BS	3	3	2.3	32	68	Fail
	KDL-2bed	3	3	3.7	-	-	Fail
FLAT6_FL03_BLD1	BD	3	3	2.0	32	23	Pass
	KDL-1bed	3	3	3.8	-	-	Fail
Studio_FL03_BLD1	SD	3	3	1.9	32	23	Pass
Studio1_FL03_BLD1	SD	3	3	2.1	32	22	Pass
Studio2_FL03_BLD1	SD	3	3	2.0	32	23	Pass
FLAT2_FL04_BLD1	BD1	4	3	1.7	32	62	Fail
	BD2	4	3	2.2	32	67	Fail
	BS	4	3	2.2	32	67	Fail
	KDLp5	4	3	4.1	-	-	Fail
FLAT1_FL02_BLD2	BD1	2	3	2.3	32	22	Pass
	BD2	2	3	2.2	32	23	Pass
	BS	2	3	2.3	32	30	Pass
	KDL-3bed	2	3	4.0	-	-	Fail
Studio1_FL02_BLD2	SD	2	3	2.0	32	23	Pass
FLAT3_FL04_BLD2	BD1	4	3	2.3	32	22	Pass
	BD2	4	3	2.1	32	20	Pass
	KDL-2bed	4	3	4.1	-	-	Fail
FLAT9_FL04_BLD2	BD	4	3	2.3	32	23	Pass
	KDL-1bed	4	3	4.0	-	-	Fail
FLAT8_FL04_BLD2	BD1	4	3	2.2	32	23	Pass
	BD2	4	3	2.0	32	21	Pass
	KDL-2bed	4	3	4.0	-	-	Fail
FLAT5_FL05_BLD2	BD	5	3	2.1	32	23	Pass
	BS	5	3	2.3	32	20	Pass
	KDL-2bed	5	3	3.8	-	-	Fail
FLAT3_FL05_BLD2	BD	5	3	2.0	32	22	Pass
	KDL-1bed	5	3	3.4	-	-	Fail
FLAT6_FL05_BLD2	BD	5	3	2.0	32	23	Pass
	KDL-1bed	5	3	3.9	-	-	Fail
FLAT7_FL05_BLD2	BD	5	3	2.0	32	22	Pass
	BS	5	3	2.2	32	20	Pass
FLAT8_FL05_BLD2	BD	5	3	2.2	32	20	Pass
	KDL-2bed	5	3	3.9	-	-	Fail
FLAT8_FL05_BLD2	BD	5	3	2.0	32	24	Pass

Apartment No.	Room Reference	Level	Max. % Exceedable Hours	Criterion 1: Hours Exceeding Comfort Range	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
	KDL-1bed	5	3	4.0	32		Fail
FLAT1_FL05_BLD3	BD1	5	3	2.1	32	20	Pass
	BS	5	3	2.2	32	33	Fail
	KDL-2bed	5	3	3.8	-	-	Fail
FLAT2_FL05_BLD3	BD	5	3	1.9	32	52	Fail
	KDL-1bed	5	3	3.4	-	-	Fail
FLAT3_FL05_BLD3	BD	5	3	1.9	32	52	Fail
	KDL-1bed	5	3	3.4	-	-	Fail
FLAT4_FL05_BLD3	BD2	5	3	1.9	32	20	Pass
	BS	5	3	2.1	32	34	Fail
	KDL-2bed	5	3	3.6	-	-	Fail
FLAT5_FL05_BLD3	BD	5	3	1.9	32	21	Pass
	BS	5	3	2.2	32	38	Fail
	KDL-2bed	5	3	4.0	-	-	Fail
FLAT6_FL05_BLD3	BD	5	3	2.1	32	24	Pass
	KDL-1bed	5	3	3.4	-	-	Fail
FLAT7_FL05_BLD3	BD	5	3	2.2	32	26	Pass
	KDL-1bed	5	3	3.6	-	-	Fail
FLAT8_FL05_BLD3	BD	5	3	2.2	32	21	Pass
	BS	5	3	2.2	32	34	Fail
	KDL-2bed	5	3	4.0	-	-	Fail
FLAT1_FL06_BLD3	BD1	6	3	2.2	32	20	Pass
	BD2	6	3	2.0	32	67	Fail
	KDL-2bed	6	3	4.0	-	-	Fail
FLAT4_FL06_BLD3	BD1	6	3	1.9	32	54	Fail
	BD2	6	3	2.0	32	20	Pass
	KDL-2bed	6	3	3.9	-	-	Fail
FLAT5_FL06_BLD3	BD	6	3	1.9	32	20	Pass
	BS	6	3	2.2	32	38	Fail
	KDL-2bed	6	3	4.1	-	-	Fail
FLAT6_FL06_BLD3	BD	6	3	2.1	32	24	Pass
	KDL-1bed	6	3	3.8	-	-	Fail
FLAT7_FL06_BLD3	BD	6	3	2.1	32	23	Pass
	KDL-1bed	6	3	3.9	-	-	Fail
FLAT8_FL06_BLD3	BD	6	3	2.2	32	22	Pass
	BS	6	3	2.2	32	37	Fail
	KDL-2bed	6	3	3.9	-	-	Fail

Table 8-2 Overheating results for the Bedrooms, Living areas and Kitchens for DSY2 London Heathrow Airport

Apartment No.	Room Reference	Level	Max. % Exceedable Hours	Criterion 1: Hours Exceeding Comfort Range	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
FLAT1_FL02_BLD1	BD1	2	3	2	32	108	Fail
	BD2	2	3	2.7	32	51	Fail
	BD3	2	3	2.7	32	58	Fail
	KDLp6	2	3	5.3	-	-	Fail
FLAT2_FL03_BLD1	BD	3	3	3.5	32	108	Fail
	KDL-1bed	3	3	6.0	-	-	Fail
FLAT3_FL03_BLD1	BD	3	3	3.6	32	99	Fail
	BS	3	3	3.6	32	90	Fail
	KDL-2bed	3	3	6.0	-	-	Fail
FLAT4_FL03_BLD1	BD	3	3	3.4	32	86	Fail
	BS	3	3	3.6	32	104	Fail
	KDL-2bed	3	3	5.8	-	-	Fail
FLAT6_FL03_BLD1	BD	3	3	3.2	32	40	Fail
	KDL-1bed	3	3	5.9	-	-	Fail
Studio_FL03_BLD1	SD	3	3	2.9	32	39	Fail
Studio1_FL03_BLD1	SD	3	3	3.3	32	39	Fail
Studio2_FL03_BLD1	SD	3	3	3.0	32	38	Fail
FLAT2_FL04_BLD1	BD1	4	3	2.9	32	99	Fail
	BD2	4	3	3.5	32	108	Fail
	BS	4	3	3.5	32	108	Fail
	KDLp5	4	3	6.5	-	-	Fail
FLAT1_FL02_BLD2	BD1	2	3	3.4	32	35	Fail
	BD2	2	3	3.6	32	38	Fail

Apartment No.	Room Reference	Level	Max. % Exceedable Hours	Criterion 1: Hours Exceeding Comfort Range	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
	BS	2	3	3.5	32	49	Fail
	KDL-3bed	2	3	6.4	-	-	Fail
Studio1_FL02_BLD2	SD	2	3	3.0	32	39	Fail
	BD1	4	3	3.7	32	37	Fail
FLAT3_FL04_BLD2	BD2	4	3	3.3	32	34	Fail
	KDL-2bed	4	3	6.4	-	-	Fail
FLAT9_FL04_BLD2	BD	4	3	3.6	32	39	Fail
	KDL-1bed	4	3	6.2	-	-	Fail
FLAT8_FL04_BLD2	BD1	4	3	3.5	32	39	Fail
	BD2	4	3	3.2	32	34	Fail
	KDL-2bed	4	3	6.2	-	-	Fail
FLAT5_FL05_BLD2	BD	5	3	3.4	32	38	Fail
	BS	5	3	3.6	32	34	Fail
	KDL-2bed	5	3	6.2	-	-	Fail
FLAT3_FL05_BLD2	BD	5	3	3.2	32	37	Fail
	KDL-1bed	5	3	5.5	-	-	Fail
FLAT6_FL05_BLD2	BD	5	3	3.1	32	39	Fail
	KDL-1bed	5	3	6.3	-	-	Fail
FLAT7_FL05_BLD2	BD	5	3	3.2	32	36	Fail
	BS	5	3	3.5	32	32	Fail
	KDL-2bed	5	3	6.1	-	-	Fail
FLAT8_FL05_BLD2	BD	5	3	3.0	32	42	Fail
	KDL-1bed	5	3	6.1	32	-	Fail
FLAT1_FL05_BLD3	BD1	5	3	3.3	32	33	Fail
	BS	5	3	3.5	32	51	Fail
	KDL-2bed	5	3	6.1	-	-	Fail
FLAT2_FL05_BLD3	BD	5	3	3.3	32	83	Fail
	KDL-1bed	5	3	5.5	-	-	Fail
FLAT3_FL05_BLD3	BD	5	3	3.3	32	83	Fail
	KDL-1bed	5	3	5.6	-	-	Fail
FLAT4_FL05_BLD3	BD2	5	3	3.0	32	35	Fail
	BS	5	3	3.4	32	53	Fail
	KDL-2bed	5	3	6.2	-	-	Fail
FLAT5_FL05_BLD3	BD	5	3	3.0	32	37	Fail
	BS	5	3	3.5	32	57	Fail
	KDL-2bed	5	3	6.3	-	-	Fail
FLAT6_FL05_BLD3	BD	5	3	3.3	32	41	Fail
	KDL-1bed	5	3	5.6	-	-	Fail
FLAT7_FL05_BLD3	BD	5	3	3.3	32	42	Fail
	KDL-1bed	5	3	6.1	-	-	Fail
FLAT8_FL05_BLD3	BD	5	3	3.4	32	34	Fail
	BS	5	3	3.4	32	54	Fail
	KDL-2bed	5	3	6.2	-	-	Fail
FLAT1_FL06_BLD3	BD1	6	3	3.3	32	31	Fail
	BD2	6	3	3.5	32	114	Fail
	KDL-2bed	6	3	6.3	-	-	Fail
FLAT4_FL06_BLD3	BD1	6	3	3.4	32	85	Fail
	BD2	6	3	3.2	32	32	Fail
FLAT5_FL06_BLD3	KDL-2bed	6	3	6.2	-	-	Fail
	BD	6	3	3.0	32	36	Fail
	BS	6	3	3.5	32	58	Fail
FLAT6_FL06_BLD3	KDL-2bed	6	3	6.2	-	-	Fail
	BD	6	3	3.2	32	41	Fail
FLAT7_FL06_BLD3	KDL-1bed	6	3	6.0	-	-	Fail
	BD	6	3	3.2	32	40	Fail
FLAT8_FL06_BLD3	KDL-1bed	6	3	6.2	-	-	Fail
	BD	6	3	3.4	32	33	Fail
	BS	6	3	3.5	32	37	Fail
	KDL-2bed	6	3	6.2	-	-	Fail

Table 8-3 Overheating results for the Bedrooms, Living areas and Kitchens for DSY3 London Heathrow Airport.

Apartment No.	Room Reference	Level	Max. % Exceedable Hours	Criterion 1: Hours Exceeding Comfort Range	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
FLAT1_FL02_BLD1	BD1	2	3	2	32	143	Fail
	BD2	2	3	1.5	32	31	Pass
	BD3	2	3	1.3	32	27	Pass
	KDLp6	2	3	2.9	-	-	Pass
FLAT2_FL03_BLD1	BD	3	3	2	32	113	Fail
	KDL-1bed	3	3	3.4	-	-	Fail
FLAT3_FL03_BLD1	BD	3	3	2.1	32	100	Fail
	BS	3	3	2	32	81	Pass
	KDL-2bed	3	3	3.3	-	-	Fail
FLAT4_FL03_BLD1	BD	3	3	2	32	102	Fail
	BS	3	3	2.1	32	90	Fail
	KDL-2bed	3	3	3.3	-	-	Fail
FLAT6_FL03_BLD1	BD	3	3	1.3	32	16	Pass
	KDL-1bed	3	3	2.5	-	-	Pass
Studio_FL03_BLD1	SD	3	3	1.2	32	16	Pass
Studio1_FL03_BLD1	SD	3	3	1.5	32	16	Pass
Studio2_FL03_BLD1	SD	3	3	1.2	32	16	Pass
FLAT2_FL04_BLD1	BD1	4	3	1.5	32	106	Fail
	BD2	4	3	2	32	114	Fail
	BS	4	3	2	32	109	Fail
	KDLp5	4	3	3.5	-	-	Fail
FLAT1_FL02_BLD2	BD1	2	3	1.7	32	16	Pass
	BD2	2	3	1.7	32	16	Pass
	BS	2	3	1.8	32	19	Pass
	KDL-3bed	2	3	2.9	-	-	Pass
Studio1_FL02_BLD2	SD	2	3	1.2	16	16	Pass
FLAT3_FL04_BLD2	BD1	4	3	2	32	21	Pass
	BD2	4	3	1.6	32	15	Pass
	KDL-2bed	4	3	3.5	-	-	Fail
FLAT9_FL04_BLD2	BD	4	3	1.8	32	17	Pass
	KDL-1bed	4	3	3	-	-	Pass
FLAT8_FL04_BLD2	BD1	4	3	1.9	32	23	Pass
	BD2	4	3	1.5	32	16	Pass
	KDL-2bed	4	3	3.4	-	-	Fail
FLAT5_FL05_BLD2	BD	5	3	1.6	32	18	Pass
	BS	5	3	2	32	14	Pass
	KDL-2bed	5	3	4.1	-	-	Fail
FLAT3_FL05_BLD2	BD	5	3	1.4	32	17	Pass
	KDL-1bed	5	3	3.4	-	-	Fail
FLAT6_FL05_BLD2	BD	5	3	1.4	32	17	Pass
	KDL-1bed	5	3	2.9	-	-	Pass
FLAT7_FL05_BLD2	BD	5	3	1.5	32	18	Pass
	BS	5	3	1.9	32	13	Pass
	KDL-2bed	5	3	3.4	-	-	Fail
FLAT8_FL05_BLD2	BD	5	3	1.3	32	17	Pass
	KDL-1bed	5	3	2.8	32	-	Pass
	BD1	5	3	1.9	32	17	Pass
FLAT1_FL05_BLD3	BS	5	3	2	32	30	Pass
	KDL-2bed	5	3	3.9	-	-	Fail
FLAT2_FL05_BLD3	BD	5	3	2	32	133	Fail
	KDL-1bed	5	3	2.8	-	-	Pass
FLAT3_FL05_BLD3	BD	5	3	2	32	132	Fail
	KDL-1bed	5	3	2.9	-	-	Pass
FLAT4_FL05_BLD3	BD2	5	3	1.5	32	17	Pass
	BS	5	3	1.9	32	27	Pass
	KDL-2bed	5	3	3.7	-	-	Fail
FLAT5_FL05_BLD3	BD	5	3	1.5	32	17	Pass
	BS	5	3	1.9	32	28	Pass
	KDL-2bed	5	3	3.6	-	-	Fail
FLAT6_FL05_BLD3	BD	5	3	1.5	32	20	Pass
	KDL-1bed	5	3	2.3	-	-	Pass
FLAT7_FL05_BLD3	BD	5	3	1.5	32	21	Pass
	KDL-1bed	5	3	2.8	-	-	Pass
FLAT8_FL05_BLD3	BD	5	3	1.7	32	17	Pass
	BS	5	3	2	32	29	Pass

Apartment No.	Room Reference	Level	Max. % Exceedable Hours	Criterion 1: Hours Exceeding Comfort Range	Max Exceedable Night Hours	Criterion 2: Number of Night Hours Exceeding 26 °C for Bedrooms.	Result
FLAT1_FL06_BLD3	KDL-2bed	5	3	3.6	-	-	Fail
	BD1	6	3	1.6	32	17	Pass
	BD2	6	3	2.7	32	299	Fail
	KDL-2bed	6	3	3.9	-	-	Fail
FLAT4_FL06_BLD3	BD1	6	3	2.1	32	166	Pass
	BD2	6	3	1.7	32	16	Pass
	KDL-2bed	6	3	3.7	-	-	Fail
FLAT5_FL06_BLD3	BD	6	3	1.5	32	18	Pass
	BS	6	3	1.9	32	22	Pass
	KDL-2bed	6	3	3.6	-	-	Fail
FLAT6_FL06_BLD3	BD	6	3	1.5	32	16	Pass
	KDL-1bed	6	3	2.7	-	-	Pass
FLAT7_FL06_BLD3	BD	6	3	1.4	32	17	Pass
	KDL-1bed	6	3	3	-	-	Fail
FLAT8_FL06_BLD3	BD	6	3	1.7	32	18	Pass
	BS	6	3	2	32	30	Pass
	KDL-2bed	6	3	3.5	-	-	Fail

Table 8-4 Overheating results for the Bedrooms, Living areas and Kitchens with minimum (Part F) ventilation rates for DSY1 London Heathrow Airport

8.3 Low and Zero Carbon Technology Feasibility Study

Source	Low Zero Carbon Technology	Lifespan (years)	Lifecycle Carbon Savings* (tCO ₂ /yr)	Applicable Grants	Life Cycle Cost*	Space Use	Local Planning Criteria	Noise	Feasibility of Export	Technology Appropriate for the site	Reasons for Inclusion/Exclusion
Solar	Photovoltaics	25	Low (325 kgCO ₂ /yr per 1 kW _{pel})	-	Medium	Suitable (roof spaces available)	Suitable	Suitable	Possible (export of power to the local grid)	No	Solar photovoltaic cells (PV) convert sunlight into usable electricity. Due to the relatively low efficiencies of this system, a large area is often required to provide a reasonable quantity of power. Provision for PV is not feasible as most roof areas are being used as outdoor residential amenity spaces and for the ASHP network.
	Solar thermal	20	Low	Renewable Heat Incentive (RHI)	Low	Suitable (roof spaces available)	Suitable	Suitable	Possible export of heat to future district heat network	No	Solar water heating is traditionally one of the more simplistic and affordable renewable technologies. Solar energy is converted to heat via panels that absorb the high-frequency heat radiation emitted from the sun. Advanced technology utilising 'heat pipes' (tubes utilising refrigerant technology) maximise useful heat extraction even on cold, cloudy days. However, the carbon saving of solar hot water depends on the fuel being displaced. A large volume of hot water storage is required for the system to be feasible. Therefore, this technology is not considered appropriate for the development.
Wind power	Wind turbines	20	Low (0.5 t/kWe per yr)	-	High	Not suitable (suitable space for stand-alone of a roof-mounted wind turbine cannot be found for the scheme)	Not Suitable due to height restriction, significant visual impact, flicker.	Potentially not suitable due to noise from the turbine's generator.	Possible (export of power to the local grid)	No	Wind turbines produce electrical energy by absorbing wind energy. They are typically available in a vertical or horizontal axis. The quantity of energy generated is directly related to the 'swept area' of the blades and as such size is of immense importance. However, smaller systems are becoming increasingly more common as well as more accepted and have been used to power schools, sports centres and business parks. A small wind turbine typically generates a small amount of energy that would prove insignificant of the site's requirements. It is expected a turbine of this nature would cost £25,000 plus £10,000 to install and as such, it would be prohibitively expensive and non-cost effective for this development. Noise generation from wind turbines can also be an issue for acoustic discomfort. For wind turbines to operate effectively, the average wind speed for the site needs to be above a threshold level of 6 m/s. Wind speeds in built-up urban areas are not reliable and therefore this technology is not considered suitable for the scheme.
Hydro, wave & tidal	Hydro power	-	-	-	-	-	-	-	-	-	No suitable water sources near the development
	Tidal power	-	-	-	-	-	-	-	-	-	
	Wave power	-	-	-	-	-	-	-	-	-	
Biofuels	Biomass boilers	20	Medium	RHI	Low-Medium	Not suitable (large space required for fuel storage)	Not suitable due to potential air quality issues	Vehicle noise during regular fuel deliveries and also removal of ash from combustion	Possible export of heat to future district heat network	No	Biomass is an organic matter of recent origin which can be replenished at the rate at which it is used. It does not include fossil fuels, which have formed over millions of years and thus of finite supply. The CO₂ released when energy is generated from biomass is balanced by that absorbed during the fuel's production. This is termed a carbon-neutral process, but only when the source of the fuels is renewable, as a sustainable rotation coppice woodland. Such fuels include logs, compressed sawdust pellets, vegetable oil and ethanol.
	Biomass Co-generation (CHP)	20	Medium-High	ROCs & RHI	Medium	Not suitable (large space required for fuel storage)	Not suitable due to potential air quality issues	Vehicle noise during regular fuel deliveries and also removal of ash from combustion	Possible export of heat to future district heat network	No	On-site fuel storage requirements requiring additional space, along with regular access to the on-site fuel storage area. Biomass/Biofuel Boiler is not considered viable as high load requirements (peak heating load) would require big biofuel/biomass storage for this scheme. Biofuel CHP with smaller capacity (consequently smaller biofuel/biomass tank) appears to be more suitable. Due to the intensive nature of biofuel use on-site in respect of deliveries, maintenance, dust and equipment responsiveness, Biofuels are not considered appropriate for this site and have been discounted in favour of more reliable fit and forget equipment.

Source	Low Zero Carbon Technology	Lifespan (years)	Lifecycle Carbon Savings* (tCO2/yr)	Applicable Grants	Life Cycle Cost*	Space Use	Local Planning Criteria	Noise	Feasibility of Export	Technology Appropriate for the site	Reasons for Inclusion/Exclusion
District heating & cooling	District heating and cooling (based on gas-fired CHP/ CCHP)	25+	Medium-High	Renewable Heat Incentive (RHI) + possible Feed-In Tariff (FiT)	Medium	Suitable	Suitable	Suitable	n/a	No	There are currently no existing district heating networks in the vicinity of the proposed development. Provision for potential future connection, should a district heating network is developed in the future.
Heat pumps	Ground source heat pumps (closed-loop system)	25 (50+ earth heat exchangers)	Medium (30-50% compared to a gas heating system)	Renewable Heat Incentive (RHI)	Medium-High	Not suitable (space not sufficient for a horizontal or vertical system)	Suitable	Suitable	Possible but unlikely	No	Ground source heat pumps utilise liquid circulation in horizontal pipes or vertical boreholes. The heat extracted is raised in temperature by the use of a heat pump and the heat is generally used to warm water for space heating, often in a form of underfloor heating. If cooling is also needed in a building, the use of the Ground Source Heat Pump (GSHP) earth loop can help replenish the heat extracted in the winter as well as making the cooling more efficient and provides the possibility of free cooling.
	Ground source heat pumps (open loop system)	25 (50+ boreholes)	Medium (40-60% compared to a gas heating system)	Renewable Heat Incentive (RHI)	Medium	Not suitable (space not sufficient to allow for required distance between boreholes)	Suitable	Suitable	Possible but unlikely	No	Ground source heat pumps (both open and closed) are not suitable for this development for the following reasons: - There is insufficient space around the building for a horizontal system; and - It is not considered economically or practically feasible to integrate pile/loop under the building (space not sufficient to allow for required distance between bore-holes). Ground source heat pumps are therefore not proposed for this scheme.
	Air source heat pumps	20	Low-Medium (20-40% compared to a gas heating system)	N/A	Low	Suitable	Not suitable due to connection to district heating network	Suitable (Acoustically insulated engine)	Possible but unlikely	Yes	Air source heat pump systems can efficiently elevate low-grade environmental heat from the air to the level required for space heating and even domestic hot water system (albeit at low efficiency). Heat pumps work much more efficiently at lower temperatures than standard boiler systems and are hence more suitable to “low-energy” underfloor heating systems or larger low-temperature radiator and fan-coil systems that are also considered low-response systems as they give out heat at lower temperatures over longer periods of time. Air-source heat pumps (ASHP) have been proposed for use on this development.
Co Generation	Gas-fired Co-generation (CHP)	15	Medium (30% CO ₂ reduction compared to condensing boilers)	N/A	Low-Medium	Suitable	Not suitable due to potential air quality issues	Suitable (acoustically insulated engine)	Possible export of heat to future district heat network	No	A CHP engine produces both heating and electrical power for a building. The benefit of generating the electricity on-site is that the waste heat that is usually rejected at power stations can be used to serve the heating and power requirements of a building or wider community. Smaller single-site systems generally utilise fossil fuels such as gas to operate a spark-ignition engine or turbine to turn a generator. Biodiesels can be used which includes correctly processed waste vegetable oil. The main vital pre-requisite of a CHP system is that demand for both power and heat is required at the same time and a baseload exists for CHP plant to operate efficiently and cost-effectively. CHP plant often has an impact on local air quality. SAP10.2 factors do not benefit gas-fired schemes in the energy analysis and as such this technology is not proposed for this scheme.
Heat recovery & energy storage	Waste heat recovery	15	Low-Medium	N/A	Low	Not suitable	Suitable	Suitable	N/A	No	Insufficient waste heat available.
	Energy storage	15 (50+ for seasonal storage)	Low-Medium (technology dependent)	N/A	Medium-High (dependant on technology)	Not suitable	Suitable	Suitable	Possible (integration within district network)	No	Large space required, energy use such that storage is required is not applicable.

8.4 Domestic Part L calculations

As a part of our BS EN ISO 14001 accreditation, we make a conscious effort to reduce the amount of printing and therefore reduce our carbon impact on the environment. For this reason, we have included a summary of all SAP results in this appendix. However, we are happy to provide all DER and TER worksheets as hard copies on request.

The summary of results for each of the stages of energy hierarchy are as below:

RESIDENTIAL CO ₂ ANALYSIS (PART L1)																					
				Baseline		'Be Lean'	'Be Clean'	'Be Green'	Fabric Energy Efficiency (FEE)		Baseline		'Be Lean'			'Be Clean'			'Be Green'		
Unit identifier (e.g. plot number, dwelling)	Model total floor area	Number of units	Total area represented by model	TER	Energy saving/generation technologies	DER	DER	DER	Target Fabric Energy Efficiency	Dwelling Fabric Energy Efficiency	Part L 2021 CO ₂ emissions	Energy saving/generation technologies	Part L 2021 CO ₂ emissions	Part L 2021 CO ₂ emissions	'Be Lean' savings	Part L 2021 CO ₂ emissions	Part L 2021 CO ₂ emissions with National PV savings	'Be Clean' savings	Part L 2021 CO ₂ emissions	'Be Green' savings	
	(m ²) (Rnu 4)		(m ²)	(kgCO ₂ / (Rnu 273))	(kgCO ₂ p.a.) (Rnu 269)	(kgCO ₂ / (Rnu 273 or 384))	(kgCO ₂ / (Rnu 273 or 384))	(kgCO ₂ / (Rnu 273 or 384))	(kWh/m ²)	(kWh/m ²)	(kgCO ₂ p.a.)	(kgCO ₂ p.a.)	(kgCO ₂ p.a.)	(kgCO ₂ p.a.)	(kgCO ₂ p.a.)	(kgCO ₂ p.a.)	(kgCO ₂ p.a.)	(kgCO ₂ p.a.)	(kgCO ₂ p.a.)	(kgCO ₂ p.a.)	
B1-01-05	46	1	276	12.73	-15.08	10.14	10.14	4.94	19.50	18.20	3,513	-90	2,799	2,708	805	2,799	2,708	0	1,363	1,345	
B1-01-02	51	2	102	12.70	-16.56	11.32	11.32	5.24	22.20	24.00	1,295	-33	1,155	1,122	174	1,155	1,122	0	534	587	
B1-01-01	48	1	48	13.79	-17.88	12.33	12.33	5.55	26.20	27.30	604	-18	604	586	89	604	586	0	272	314	
B1-01-02	51	6	306	10.99	-14.02	9.30	9.30	4.72	13.70	14.60	3,363	-84	2,846	2,762	601	2,846	2,762	0	1,444	1,317	
B1-03-05	46	2	92	12.74	-14.93	10.08	10.08	4.85	19.60	18.40	1,172	-30	927	898	275	927	898	0	446	451	
B1-03-07	46	1	46	12.90	-15.29	10.38	10.38	4.91	21.00	19.70	593	-15	477	462	131	477	462	0	226	236	
B1-03-02	64	2	128	10.37	-13.99	9.38	9.38	4.61	16.80	17.60	1,327	-28	1,201	1,173	155	1,201	1,173	0	590	583	
B1-03-03	50	1	50	11.16	-14.01	9.34	9.34	4.67	14.20	15.10	558	-14	467	453	105	467	453	0	234	219	
B1-01-01	118.12	2	236.24	8.62	-13.90	9.33	9.33	4.57	21.80	22.10	1,898	-28	2,055	2,027	-129	2,055	2,027	0	1,006	1,021	
B1-04-03	77.63	1	77.63	13.29	-19.22	13.47	13.47	5.75	36.00	36.80	1,034	-19	1,048	1,029	5	1,048	1,029	0	448	582	
B1-04-02	88.07	1	88.07	11.09	-19.36	13.50	13.50	5.86	32.10	36.50	1,099	-19	1,337	1,318	-219	1,337	1,318	0	581	738	
B2-01-06	53	4	212	14.13	-17.01	11.86	11.86	5.15	29.50	28.00	2,996	-68	2,514	2,446	549	2,514	2,446	0	1,092	1,354	
B2-01-08	68	6	368	13.60	-16.98	11.82	11.82	5.16	29.90	28.40	4,896	-102	4,255	4,153	743	4,255	4,153	0	1,858	2,296	
B2-01-05	63	4	252	11.30	-16.63	11.46	11.46	5.17	22.40	24.00	2,848	-67	2,888	2,821	26	2,888	2,821	0	1,303	1,519	
B2-00-02	46	2	92	13.99	-16.27	11.18	11.18	5.09	24.40	23.50	1,287	-33	1,029	996	291	1,029	996	0	468	528	
B2-01-10	50	2	100	12.12	-14.07	9.49	9.49	4.58	18.10	17.40	1,212	-28	949	921	291	949	921	0	458	463	
B2-01-11	50	2	100	13.07	-15.00	10.20	10.20	4.80	22.00	20.10	1,307	-30	1,020	990	317	1,020	990	0	480	510	
B2-01-02	63	10	630	10.56	-13.21	8.82	8.82	4.39	16.70	15.90	6,653	-132	5,557	5,425	1,228	5,557	5,425	0	2,766	2,659	
B2-00-01	74.28	1	74.28	11.95	-16.92	11.63	11.63	5.29	27.60	26.70	888	-17	864	847	41	864	847	0	393	454	
B2-00-03	52.26	1	52.26	16.96	-21.29	15.19	15.19	6.10	41.70	40.70	886	-21	794	773	114	794	773	0	319	454	
B2-00-05	13.11	1	13.11	12.00	-17.24	12.04	12.04	5.20	31.30	32.70	997	-17	1,001	983	14	1,001	983	0	432	551	
B2-01-01	86.80	2	173.60	8.25	-13.25	8.73	8.73	4.52	16.20	16.90	1,600	-27	1,693	1,667	-67	1,693	1,667	0	877	790	
B2-01-07	63.62	4	254.48	12.26	-15.90	11.01	11.01	4.89	26.40	25.70	3,120	-64	2,802	2,738	382	2,802	2,738	0	1,244	1,494	
B2-03-02	38.18	1	38.18	14.94	-16.76	11.53	11.53	5.23	24.80	23.40	595	-17	459	443	153	459	443	0	208	234	
B2-03-10	50	1	50	12.96	-15.07	10.29	10.29	4.78	22.10	20.80	648	-15	515	499	149	515	499	0	239	260	
B2-04-03	88.71	1	88.71	9.72	-15.62	10.68	10.68	4.94	22.90	25.30	872	-16	958	942	-71	958	942	0	443	499	
B2-04-08	88.71	1	88.71	9.84	-15.77	10.80	10.80	4.97	23.40	25.60	883	-16	969	953	-70	969	953	0	446	507	
B2-04-09	63	1	63	9.97	-12.84	8.52	8.52	4.32	13.20	13.90	628	-13	537	524	104	537	524	0	272	252	
B2-05-03	51.4	1	51.4	14.80	-18.64	13.08	13.08	5.56	31.80	31.80	761	-19	672	654	107	672	654	0	286	368	
B2-05-05	63	1	63	13.05	-19.74	13.89	13.89	5.85	30.40	33.50	822	-20	875	855	-33	875	855	0	369	487	
B2-05-06	53	1	53	16.38	-21.02	15.00	15.00	6.02	40.00	40.10	868	-21	795	774	94	795	774	0	319	455	
B2-05-07	63.62	1	63.62	14.13	-19.20	13.59	13.59	5.61	34.80	35.60	899	-19	865	845	54	865	845	0	357	488	
B3-00-01	62.54	1	62.54	13.38	-17.84	13.26	13.26	4.58	36.40	37.00	1,104	-18	1,094	1,077	28	1,094	1,077	0	378	699	
B3-01-01	62.56	1	62.56	13.34	-15.49	11.64	11.64	3.85	29.70	31.60	832	-15	726	710	70	726	710	0	240	470	
B3-01-02	51.64	2	103.28	13.53	-13.39	9.97	9.97	3.42	24.90	23.90	1,403	-27	1,034	1,007	396	1,034	1,007	0	355	652	
B3-01-04	62.56	1	62.56	14.99	-16.90	12.78	12.78	4.12	37.10	36.20	935	-17	797	780	155	797	780	0	257	523	
B3-01-05	62.56	1	62.56	14.99	-16.90	12.78	12.78	4.12	37.10	36.20	935	-17	797	780	155	797	780	0	257	523	
B3-01-06	51.64	2	103.28	13.70	-13.82	10.36	10.36	3.46	26.20	25.90	1,420	-28	1,074	1,046	374	1,074	1,046	0	359	688	
B3-01-08	62.56	1	62.56	8.93	-9.16	6.64	6.64	2.52	8.50	7.40	557	-9	414	405	152	414	405	0	157	248	
B3-02-02	51.64	8	413.12	11.57	-10.84	7.87	7.87	2.97	15.30	14.10	4,798	-87	3,264	3,177	1,621	3,264	3,177	0	1,232	1,945	
B3-02-04	62.56	4	250.24	12.82	-13.87	10.34	10.34	3.53	27.30	26.70	3,198	-55	2,579	2,524	674	2,579	2,524	0	881	1,643	
B3-02-05	62.56	4	250.24	12.82	-13.87	10.34	10.34	3.53	27.30	26.70	3,198	-55	2,579	2,524	674	2,579	2,524	0	881	1,643	
B3-02-06	51.64	8	413.12	11.76	-11.14	8.16	8.16	2.98	16.90	16.20	4,877	-89	3,384	3,295	1,582	3,384	3,295	0	1,236	2,059	
B3-02-08	62.56	4	250.24	8.93	-9.16	6.64	6.64	2.52	8.50	7.40	2,227	-37	1,656	1,620	608	1,656	1,620	0	629	991	
B3-02-01	62.56	4	250.24	11.43	-12.71	9.39	9.39	3.32	20.90	22.50	2,851	-51	2,342	2,291	560	2,342	2,291	0	828	1,463	
B3-06-01	71.00	1	71.00	13.31	-16.51	12.36	12.36	4.15	33.00	35.60	946	-17	879	862	84	879	862	0	295	567	
B3-06-04	71.00	1	71.00	14.05	-17.18	12.90	12.90	4.28	36.30	37.70	999	-17	917	900	99	917	900	0	304	596	
B3-06-05	62.56	1	62.56	14.75	-17.09	12.94	12.94	4.15	36.00	36.80	920	-17	807	790	130	807	790	0	259	531	
B3-06-06	51.64	2	103.28	13.47	-13.82	10.36	10.36	3.46	25.20	25.90	1,397	-28	1,074	1,046	350	1,074	1,046	0	359	688	
B3-06-08	62.56	1	62.56	9.88	-11.00	8.16	8.16	2.84	13.50	14.70	616	-11	509	498	118	509	498	0	177	321	
Sum		120	7,151	11.9	-14.5	10.2	10.2	4.3	22.5	22.4	85,408	-1,733	72,853	71,820	14,288	72,853	71,820	0	38,854	48,264	

Sample SAP Unit B119 – Demand Reduction



DER WORKSHEET

Dwelling Reference: B119
Dwelling Type: New Dwelling Design Stage
Eaton Court
Oxford Road
READING
RG1 7FU

1. Overall dwelling dimensions

	Area(m²)	Av. Height(m)	Volume(m³)
Ground Floor	49	{ 1a } x 2.75	{ 2a } = 134.75
Total floor area TFA			49
Dwelling volume			134.75

2. Ventilation Rate

Chimneys/Flues	0	x 80 =	0
Open chimneys	0	x 20 =	0
Chimneys / flues attached to closed fire	0	x 10 =	0
Flues attached to solid fuel boiler	0	x 20 =	0
Flues attached to other heater	0	x 35 =	0
Number of blocked chimneys	0	x 20 =	0
Number of intermittent extract fans	0	x 10 =	0
Number of passive vents	0	x 10 =	0
Number of fuelless gas fires	0	x 40 =	0

Air changes per hour

Number of storeys in the dwelling (ns)	0	0
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0
Additional infiltration	0	0
Structural infiltration	0	0
Suspended wooden ground floor	0	0
No draught lobby	0	0
Percentage of windows and doors draught proofed	0	0
Window infiltration	0	0
Infiltration rate	0	0
Air permeability value, AP50, (m³/h/m²)	2	2
Air permeability value, AP4, (m³/h/m²)	0	0
Air permeability value)	0.1	0.1
Number of sides on which dwelling is sheltered	1	1
Shelter factor		0.92



DER WORKSHEET

Page 1



DER WORKSHEET

Infiltration rate incorporating shelter factor	0.09	{ 21 }
Infiltration rate modified for monthly wind speed		
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Total		{ 22 }
Monthly average wind speed from Table U2		
5.1 5 4.9 4.4 4.3 3.8 3.8 3.7 4 4.3 4.5 4.7	52.5	{ 22 }
Wind Factor		
1.28 1.25 1.23 1.1 1.08 0.95 0.95 0.93 1 1.08 1.13 1.18	13.13	{ 22a }
Adjusted infiltration rate (allowing for shelter and wind speed)		
0.12 0.12 0.11 0.1 0.1 0.09 0.09 0.09 0.1 0.1 0.11	1.21	{ 22b }
Calculate effective air change rate for the applicable case:		
	0.5	{ 23a }
	0.5	{ 23b }
	45	{ 23c }

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.39 0.39 0.39 0.38 0.37 0.36 0.36 0.36 0.37 0.37 0.38 0.38	{ 24a }
---	---------

b) If balanced mechanical ventilation without heat recovery (MV)

0 0 0 0 0 0 0 0 0 0 0 0	{ 24b }
-------------------------	---------

c) If whole house extract ventilation or positive input ventilation from outside

0 0 0 0 0 0 0 0 0 0 0 0	{ 24c }
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d) If natural ventilation or whole house positive input ventilation from loft

0 0 0 0 0 0 0 0 0 0 0 0	{ 24d }
-------------------------	---------

Effective air change rate

0.39 0.39 0.39 0.38 0.37 0.36 0.36 0.36 0.37 0.37 0.38 0.38	{ 25 }
---	--------

Effective air change rate from PCDB:

0.39 0.39 0.39 0.38 0.37 0.36 0.36 0.36 0.37 0.37 0.38 0.38	{ 25 }
---	--------

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k-value

ELEMENT	Gross area (m²)	Openings m²	Net Area A, m²	U-value W/m²K	A X U (W/K)	k-value kJ/m².K	A X k kJ/K
Solid door						0	{ 26 }
Semi-glazed door						0	{ 26a }
Window						9.14	{ 27 }
Roof window						0	{ 27a }
Basement floor				0		0	{ 28 }
Ground floor				5390		5.88	{ 28a }
Exposed floor				0		0	{ 28b }
Basement wall				0		0	{ 29 }
External wall				3423		3.42	{ 29a }
Roof				0		0	{ 30 }



DER WORKSHEET

Page 2



DER WORKSHEET

Total area of external elements ΣA, m²	79.8	{ 31 }
Party Wall	0	{ 32 }
Party floor	0	{ 32a }
Party ceiling	0	{ 32b }
Internal wall **	0	{ 33c }
Internal floor	0	{ 32d }
Internal ceiling floor	0	{ 32e }
Fabric heat loss, W/K = Σ (A x U)	18.44	{ 33 }
Heat capacity Cm = Σ (A x k)	10276	{ 34 }
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K	250	{ 35 }
Linear Thermal bridges: Σχ (W/K) calculated using Appendix K	3.99	{ 36 }
Point Thermal bridges: Σχ (W/K) if significant point thermal bridge present and values available	3.99	{ 36a }
Total fabric heat loss H = Σ (A x U) + Σ (L x Ψ) + Σ χ	22.43	{ 37 }
Ventilation heat loss calculated monthly		
17.47 17.37 17.27 16.75 16.65 16.14 16.14 16.03 16.34 16.65 16.86 17.06	{ 38 }	
Heat transfer coefficient, W/K		
39.9 39.8 39.7 39.18 39.08 38.57 38.57 38.46 38.77 39.08 39.29 39.49	{ 39 }	
Heat loss parameter (HLP), W/m²K		
0.81 0.81 0.81 0.8 0.8 0.79 0.79 0.78 0.79 0.8 0.8 0.81	{ 40 }	
Number of days in month (Table 1a)		
31 28 31 30 31 31 31 30 31 30 31	{ 41 }	

4. Water heating energy requirement

Assumed occupancy, N

1.66 { 42 }

Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)

0 0 0 0 0 0 0 0 0 0 0 0	{ 42a }
-------------------------	---------

Hot water usage in litres per day for baths, Vd,bath (from Appendix J)

59.97 59.08 57.83 55.51 53.78 51.86 50.82 52.07 53.43 55.48 57.84 59.77	{ 42b }
---	---------

Hot water usage in litres per day for other uses, Vd,other (from Appendix J)

31.64 30.49 29.34 28.19 27.04 25.89 25.89 27.04 28.19 29.34 30.49 31.64	{ 42c }
---	---------

Annual average hot water usage in litres per day Vd,average (from Appendix J)

84.36	{ 43 }
-------	--------

Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)

91.61 89.57 87.16 83.7 80.82 77.75 76.71 79.11 81.61 84.82 88.33 91.4	1012.57 { 44 }
---	----------------

Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)

145.08 127.54 133.96 114.58 108.8 95.6 92.77 97.95 100.64 115.1 125.84 143.12	1400.97 { 45 }
---	----------------

Distribution loss (46) = 0.15 x (45)

21.76 19.13 20.09 17.19 16.32 14.34 13.92 14.69 15.1 17.26 18.88 21.47	{ 46 }
--	--------

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

0 { 47 }

Water storage loss (or HIU loss)

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

0 { 48 }



DER WORKSHEET

Page 3



DER WORKSHEET

Temperature factor from Table 2b	0	(49)
Energy lost from water storage, kWh/day (48) x (49) =	0	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0	(51)
Volume factor from Table 2a	0	(52)
Temperature factor from Table 2b	0	(53)
Energy lost from water storage, kWh/day	0	(54)
Enter (50) or (54) in (55)	0	(55)
Water storage (or HIU) loss calculated for each month (56) = (55) x (41)		
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		(56)
If the vessel contains dedicated solar storage or dedicated WWHRS storage, (57)m = (56)m ÷ [(47) – Vs] + (47), else (57)m = (56)m where Vs is Vww from Appendix G3 or (H12) from Appendix H (as applicable).		
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		(57)
Primary circuit loss for each month from Table 3 modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks]		
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		(59)
Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)		
46.68 41.23 44.42 41.28 41.18 38.34 39.09 40.31 40.25 43.22 43.56 46.58		(61)
Total heat required for water heating calculated for each month (62) = 0.85 x (45) + (46) + (57) + (59) + (61)		
191.77 168.77 178.38 155.86 149.98 133.94 131.86 138.26 140.88 158.32 169.4 189.7		1907.1 (62)
CWWHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRS contribution to water heating)		
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		(63a)
PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)		
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		(63b)
Solar DHW input calculated using Appendix H (negative quantity) (enter 0 if no solar contribution to water heating)		
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		(63c)
FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)		
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		(63d)
Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)		
191.77 168.77 178.38 155.86 149.98 133.94 131.86 138.26 140.88 158.32 169.4 189.7		1907.1 (64)
Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)		
0 0 0 0 0 0 0 0 0 0 0 0 0 0 0		(64a)
Heat gains from water heating, kWh/month 0.25 x [(0.85 x (45) + (61) + (64a))] + 0.8 x [(46) + (57) + (59)]		
59.91 52.71 55.65 48.42 46.47 41.37 40.62 42.65 43.52 49.07 52.73 59.23		(65)
include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network		

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts		
83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04		(66)



DER WORKSHEET

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5		
75.85 83.97 75.85 78.38 75.85 78.38 75.85 78.38 75.85 78.38 75.85		(67)
Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5		
144.64 146.14 142.36 134.3 124.14 114.59 108.21 106.7 110.49 118.54 128.7 138.26		(68)
Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5		
31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3		(69)
Pumps and fans gains (Table 5a)		
3 3 3 3 3 0 0 0 0 3 3 3		(70)
Losses e.g. evaporation (negative values) (Table 5)		
-66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43		(71)
Water heating gains (Table 5)		
80.53 78.44 74.79 67.25 62.46 57.46 54.6 57.32 60.45 65.96 73.24 79.61		(72)
Total internal gains		
351.92 359.47 343.91 330.84 313.36 298.33 286.56 287.78 297.22 311.26 331.23 344.63		(73)

6. Solar gains

Solar gains in watts, calculated for each month		
54.9 89.91 114.53 129.44 134.89 129.81 126.83 123.17 119.64 96.97 65.07 47.44		(83)
Total gains – internal and solar (watts)		
406.82 449.37 458.44 460.28 448.24 428.14 413.39 410.95 416.86 408.23 396.3 392.06		(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)	21	(85)
Utilisation factor for gains for living area, Tl1,m (see Table 9a)		
0.99 0.97 0.95 0.88 0.77 0.57 0.41 0.43 0.63 0.87 0.97 0.99		(86)
Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)		
20.38 20.52 20.67 20.84 20.95 20.99 21 21 20.99 20.88 20.62 20.36		(87)
Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)		
20.24 20.24 20.24 20.25 20.26 20.26 20.26 20.27 20.26 20.26 20.25 20.25		(88)
Roof Utilisation factor for gains for rest of dwelling, Tl2,m (see Table 9a)		
0.98 0.96 0.93 0.86 0.72 0.51 0.34 0.36 0.57 0.84 0.96 0.98		(89)
Roof Mean internal temperature in the rest of dwelling T2		
19.53 19.71 19.89 20.1 20.22 20.26 20.26 20.27 20.25 20.15 19.84 19.51		(90)
Living area fraction	0.48	(91)
Mean internal temperature (for the whole dwelling)		
19.94 20.1 20.26 20.46 20.57 20.61 20.62 20.62 20.6 20.5 20.21 19.91		(92)
Adjusted mean internal temperature:		
19.94 20.1 20.26 20.46 20.57 20.61 20.62 20.62 20.6 20.5 20.21 19.91		(93)

8. Space heating requirement

ST20MA	Page 5
DER WORKSHEET	



DER WORKSHEET

Utilisation factor for gains,		
0.98 0.96 0.93 0.86 0.74 0.54 0.37 0.39 0.6 0.85 0.96 0.98		(94)
Useful gains, mGm , W		
398.39 431.82 427.81 397.85 330.8 230.27 154.75 162.01 248.96 345.83 378.51 385.34		(95)
Monthly average external temperature from Table U1		
4.3 4.9 6.5 8.9 11.7 14.6 16.6 16.4 14.1 10.6 7.1 4.2		(96)
Heat loss rate for mean internal temperature		
624 604.9 546.36 452.79 346.57 231.84 154.86 162.17 252.21 386.77 515.08 620.49		(97)
Space heating requirement for each month		
167.85 116.31 88.2 39.56 11.73 0 0 0 0 30.46 98.33 174.95		(98a)
Solar space heating calculated using Appendix H (negative quantity)		
0 0 0 0 0 0 0 0 0 0 0 0		(98b)
Space heating requirement for each month after solar contribution		
167.85 116.31 88.2 39.56 11.73 0 0 0 0 30.46 98.33 174.95		(98c)
Space heating requirement in kWh/m ² /year	14.84	(99)

8c. Space Cooling requirement

Heat loss rate,		
0 0 0 0 0 0 0 0 0 0 0 0		(100)
Utilisation factor for loss		
0 0 0 0 0 0 0 0 0 0 0 0		(101)
Useful loss, mLm (watts)		
0 0 0 0 0 0 0 0 0 0 0 0		(102)
Gains		
0 0 0 0 0 0 0 0 0 0 0 0		(103)
Space cooling requirement for month, whole dwelling, continuous (kWh)		(104)
0 0 0 0 0 0 0 0 0 0 0 0		(104)
Cooled fraction		0 (105)
Intermittency factor		
0 0 0 0 0 0 0 0 0 0 0 0		(106)
Space cooling requirement for month		0 (107)
0 0 0 0 0 0 0 0 0 0 0 0		(107)
Space cooling requirement in kWh/m ² /year	0	(108)

8f. Space heating requirement

Fabric Energy Efficiency,	0	0	(109)
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9a. Energy requirements – Individual heating systems including micro-CHP






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Fuel required	kWh/year	Fuel price	Fuel cost £/year
Space heating - main system 1 (electric off-peak tariff)			
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		33.1 (240a)
Low-rate fraction	0		33.1 (240b)
High-rate cost	0	0	240c)
Low-rate cost	0	0	240d)
Space heating - main system 1 cost (other fuel)	0		0 (240e)
Space heating - main system 2 (electric off-peak tariff)			
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		33.1 (241a)
Low-rate fraction	0		33.1 (241b)
High-rate cost	0	0	241c)
Low-rate cost	0	0	241d)
Space heating - main system 2 cost (other fuel)	0		0 (241e)
Space heating - secondary (electric off-peak tariff)			
High-rate fraction (Table 12a, or Appendix F for electric CPSU)	0		33.1 (242a)



	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating - main system 1			190.94	(261)
Space heating - main system 2			0	(262)
Space heating - secondary			0	(263)
Energy for water heating			324.21	(264)
Energy for instantaneous electric shower(s)			0	(264a)



Sample SAP Unit B119 – Renewable Energy



DER WORKSHEET

Space and water heating		515.15	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		29.03	(267)
Electricity for lighting		59.95	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used		0	(271b)
Total CO ₂ , kg/year		604.13	(272)
Dwelling CO ₂ Emission Rate		12.33	(273)
EI rating		91	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissions kg CO ₂ /year	
Space heating - main system 1			1027.45	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3578.2	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			4605.65	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			316.62	(281)
Electricity for lighting			637.07	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			5559.34	(286)
Dwelling PE Rate			113.46	(287)



DER WORKSHEET

Page 10



DER WORKSHEET

Dwelling Reference: B119
Dwelling Type: New Dwelling Design Stage
Eaton Court
Oxford Road
READING
RG1 7FU

1. Overall dwelling dimensions

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground Floor	49 { 1a) x 2.75	{ 2a) =	134.75 { 3a)
Total floor area TFA			49 { 4)
Dwelling volume			134.75 { 5)

2. Ventilation Rate

Chimneys/Flues	0	x 80 =	0 { 6a)
Open chimneys	0	x 20 =	0 { 6b)
Chimneys / flues attached to closed fire	0	x 10 =	0 { 6c)
Flues attached to solid fuel boiler	0	x 20 =	0 { 6d)
Flues attached to other heater	0	x 35 =	0 { 6e)
Number of blocked chimneys	0	x 20 =	0 { 6f)
Number of intermittent extract 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	
Number of storeys in the dwelling (ns)	0		0 { 8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0		0 { 9)
Additional infiltration	0		0 { 10)
Structural infiltration	0		0 { 11)
Suspended wooden ground floor	0		0 { 12)
No draught lobby	0		0 { 13)
Percentage of windows and doors draught proofed	0		0 { 14)
Window infiltration	0		0 { 15)
Infiltration rate	0		0 { 16)
Air permeability value, AP50, (m ³ /h/m ²)	2		2 { 17)
Air permeability value, AP4, (m ³ /h/m ²)	0		0 { 17a)
Air permeability value)	0.1		0.1 { 18)
Number of sides on which dwelling is sheltered	1		1 { 19)
Shelter factor			0.92 { 20)



DER WORKSHEET

Page 1



DER WORKSHEET

Infiltration rate incorporating shelter factor																	0.09	{ 21)
Infiltration rate modified for monthly wind speed																		
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec					Total	{ 22)
Monthly average wind speed from Table U2																		
Wind Factor	5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7					52.5	{ 22)
Adjusted infiltration rate (allowing for shelter and wind speed)	1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18					13.13	{ 22a)
Calculate effective air change rate for the applicable case:	0.12	0.12	0.11	0.1	0.1	0.09	0.09	0.09	0.09	0.1	0.1	0.11					1.21	{ 22b)
																	0.5	{ 23a)
																	0.5	{ 23b)
																	45	{ 23c)
a) If balanced mechanical ventilation with heat recovery (MVHR)	0.39	0.39	0.39	0.38	0.37	0.36	0.36	0.36	0.37	0.37	0.38	0.38						{ 24a)
b) If balanced mechanical ventilation without heat recovery (MV)	0	0	0	0	0	0	0	0	0	0	0	0						{ 24b)
c) If whole house extract ventilation or positive input ventilation from outside	0	0	0	0	0	0	0	0	0	0	0	0						{ 24c)
d) If natural ventilation or whole house positive input ventilation from loft	0	0	0	0	0	0	0	0	0	0	0	0						{ 24d)
Effective air change rate	0.39	0.39	0.39	0.38	0.37	0.36	0.36	0.36	0.37	0.37	0.38	0.38						{ 25)
Effective air change rate from PCDB:	0.39	0.39	0.39	0.38	0.37	0.36	0.36	0.36	0.37	0.37	0.38	0.38						{ 25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k-value

ELEMENT	Gross area (m ²)	Openings m ²	Net Area A _n m ²	U-value W/m ² K	A X U (W/K)	k-value kJ/m ² -K	A X k kJ/K
Solid door						0	0 { 26)
Semi-glazed door						0	0 { 26a)
Window						9.14	9.14 { 27)
Roof window						0	0 { 27a)
Basement floor				0		0	0 { 28)
Ground floor				5390		5.88	5.88 { 28a)
Exposed floor				0		0	0 { 28b)
Basement wall				0		0	0 { 29)
External wall				3423		3.42	3.42 { 29a)
Roof				0		0	0 { 30)



DER WORKSHEET

Page 2



DER WORKSHEET

Total area of external elements ΣA , m ²	79.8	(31)
Party Wall	0	(32)
Party floor	0	(32a)
Party ceiling	0	(32b)
Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = $\Sigma (A \times U)$	18.44	(33)
Heat capacity Cm = $\Sigma (A \times k)$	10276	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m ² K	250	(35)
Linear Thermal bridges: $\Sigma (L \times \Psi)$ calculated using Appendix K	3.99	(36)
Point Thermal bridges: $\Sigma \chi$ (W/K) if significant point thermal bridge present and values available	3.99	(36a)
Total fabric heat loss H = $\Sigma (A \times U) + \Sigma (L \times \Psi) + \Sigma \chi$	22.43	(37)
Ventilation heat loss calculated monthly		
17.47 17.37 17.27 16.75 16.65 16.14 16.14 16.03 16.34 16.65 16.86 17.06		(38)
Heat transfer coefficient, W/K		
39.9 39.8 39.7 39.18 39.08 38.57 38.57 38.46 38.77 39.08 39.29 39.49		(39)
Heat loss parameter (HLP), W/m ² K		
0.81 0.81 0.81 0.8 0.8 0.79 0.79 0.78 0.79 0.8 0.8 0.81		(40)
Number of days in month (Table 1a)		
31 28 31 30 31 30 31 31 30 31 30 31		(41)

4. Water heating energy requirement

Assumed occupancy, N	1.66	(42)
Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)		
0 0 0 0 0 0 0 0 0 0 0 0		(42a)
Hot water usage in litres per day for baths, Vd,bath (from Appendix J)		
59.97 59.08 57.83 55.51 53.78 51.86 50.82 52.07 53.43 55.48 57.84 59.77		(42b)
Hot water usage in litres per day for other uses, Vd,other (from Appendix J)		
31.64 30.49 29.34 28.19 27.04 25.89 25.89 27.04 28.19 29.34 30.49 31.64		(42c)
Annual average hot water usage in litres per day Vd,average (from Appendix J)	84.36	(43)
Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)		
91.61 89.57 87.16 83.7 80.82 77.75 76.71 79.11 81.61 84.82 88.33 91.4	1012.57	(44)
Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)		
145.08 127.54 133.96 114.58 108.8 95.6 92.77 97.95 100.64 115.1 125.84 143.12	1400.97	(45)
Distribution loss (46) = 0.15 x (45)		
21.76 19.13 20.09 17.19 16.32 14.34 13.92 14.69 15.1 17.26 18.88 21.47		(46)
Storage volume (litres) including any solar or WWHRs storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	0	(48)



Page 3

DER WORKSHEET



DER WORKSHEET

Temperature factor from Table 2b	0	(49)
Energy lost from water storage, kWh/day (48) x (49) =	110	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	0.6	(53)
Energy lost from water storage, kWh/day	1.03	(54)
Enter (50) or (54) in (55)	1.03	(55)
Water storage (or HIU) loss calculated for each month (56) = (55) x (41)		
32.01 28.92 32.01 30.98 32.01 30.98 32.01 32.01 30.98 32.01 30.98 32.01		(56)
If the vessel contains dedicated solar storage or dedicated WWHRs storage,		
(57)m = (56)m ÷ [(47) – Vs] ÷ (47), else (57)m = (56)m		
where Vs is V _{ww} from Appendix G3 or (H12) from Appendix H (as applicable).		
32.01 28.92 32.01 30.98 32.01 30.98 32.01 32.01 30.98 32.01 30.98 32.01		(57)
Primary circuit loss for each month from Table 3		
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks]		
23.26 21.01 23.26 22.51 23.26 22.51 23.26 23.26 22.51 23.26 22.51 23.26		(59)
Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)		
0 0 0 0 0 0 0 0 0 0 0 0		(61)
Total heat required for water heating calculated for each month (62) = 0.85 x (45) + (46) + (57) + (59) + (61)		
200.36 177.47 189.24 168.07 164.07 149.09 148.05 153.23 154.13 170.37 179.33 198.39	2051.81	(62)
CWWHRs DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRs contribution to water heating)		
0 0 0 0 0 0 0 0 0 0 0 0		(63a)
PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)		
0 0 0 0 0 0 0 0 0 0 0 0		(63b)
Solar DHW input calculated using Appendix H (negative quantity) (enter 0 if no solar contribution to water heating)		
0 0 0 0 0 0 0 0 0 0 0 0		(63c)
FGHRS DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRS contribution to water heating)		
0 0 0 0 0 0 0 0 0 0 0 0		(63d)
Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)		
200.36 177.47 189.24 168.07 164.07 149.09 148.05 153.23 154.13 170.37 179.33 198.39	2051.81	(64)
Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)		
0 0 0 0 0 0 0 0 0 0 0 0		(64a)
Heat gains from water heating, kWh/month 0.25 x [0.85 x (45) + (61) + (64a)] + 0.8 x [(46) + (57) + (59)]		
92.46 82.35 88.76 80.89 80.4 74.58 75.07 76.79 76.26 82.49 84.64 91.81		(65)
include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network		

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts		
83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04 83.04		(66)



Page 4

DER WORKSHEET



DER WORKSHEET

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5		
75.85 83.97 75.85 78.38 75.85 78.38 75.85 75.85 78.38 75.85 78.38 75.85		(67)
Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5		
144.64 146.14 142.36 134.3 124.14 114.59 108.21 106.7 110.49 118.54 128.7 138.26		(68)
Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5		
31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3 31.3		(69)
Pumps and fans gains (Table 5a)		
0 0 0 0 0 0 0 0 0 0 0 0		(70)
Losses e.g. evaporation (negative values) (Table 5)		
-66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43 -66.43		(71)
Water heating gains (Table 5)		
124.28 122.54 119.31 112.35 108.06 103.59 100.9 103.21 105.91 110.87 117.55 123.4		(72)
Total internal gains		
392.67 400.57 385.42 372.94 355.96 344.46 332.86 333.67 342.68 353.17 372.54 385.41		(73)

6. Solar gains

Solar gains in watts, calculated for each month		
54.9 89.91 114.53 129.44 134.89 129.81 126.83 123.17 119.64 96.97 65.07 47.44		(83)
Total gains – internal and solar (watts)		
447.57 490.48 499.95 502.38 490.84 474.27 459.69 456.84 462.32 450.15 437.61 432.85		(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)	21	(85)
Utilisation factor for gains for living area, B1,m (see Table 9a)		
0.98 0.96 0.92 0.85 0.71 0.52 0.37 0.39 0.57 0.82 0.95 0.98		(86)
Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)		
20.47 20.6 20.73 20.88 20.97 21 21 21 20.99 20.92 20.69 20.44		(87)
Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)		
20.24 20.24 20.24 20.25 20.26 20.26 20.26 20.27 20.26 20.26 20.25 20.25		(88)
Roof		
Utilisation factor for gains for rest of dwelling, B2,m (see Table 9a)		
0.97 0.94 0.91 0.81 0.66 0.46 0.31 0.33 0.51 0.78 0.93 0.97		(89)
Roof		
Mean internal temperature in the rest of dwelling T2		
19.77 19.9 20.03 20.17 20.24 20.26 20.26 20.27 20.26 20.2 20 19.75		(90)
Living area fraction	0.48	(91)
Mean internal temperature (for the whole dwelling)		
20.1 20.23 20.36 20.51 20.59 20.61 20.62 20.62 20.61 20.54 20.33 20.08		(92)
Adjusted mean internal temperature:		
20.1 20.23 20.36 20.51 20.59 20.61 20.62 20.62 20.61 20.54 20.33 20.08		(93)

8. Space heating requirement



Page 5

DER WORKSHEET



DER WORKSHEET

Utilisation factor for gains,	0.97	0.94	0.91	0.82	0.69	0.49	0.34	0.35	0.54	0.8	0.93	0.97	(94)
Useful gains, mGm , W	433.42	463.12	454.06	414.23	336.93	231.06	154.81	162.1	250.55	359.91	408.36	421.19	(95)
Monthly average external temperature from Table U1	4.3	4.9	6.5	8.9	11.7	14.6	16.6	16.4	14.1	10.6	7.1	4.2	(96)
Heat loss rate for mean internal temperature	630.55	610.26	550.4	454.93	347.27	231.92	154.87	162.18	252.38	388.5	519.71	627.21	(97)
Space heating requirement for each month	146.66	98.88	71.68	29.3	7.69	0	0	0	0	21.27	80.17	153.27	(98a)
Solar space heating calculated using Appendix H (negative quantity)	0	0	0	0	0	0	0	0	0	0	0	0	(98b)
Space heating requirement for each month after solar contribution	146.66	98.88	71.68	29.3	7.69	0	0	0	0	21.27	80.17	153.27	(98c)
Space heating requirement in kWh/m ² /year												12.43	(99)

8c. Space Cooling requirement

Heat loss rate,	0	0	0	0	0	0	0	0	0	0	0	0	(100)
Utilisation factor for loss	0	0	0	0	0	0	0	0	0	0	0	0	(101)
Useful loss, mLm (watts)	0	0	0	0	0	0	0	0	0	0	0	0	(102)
Gains	0	0	0	0	0	0	0	0	0	0	0	0	(103)
Space cooling requirement for month, whole dwelling, continuous (kWh)	0	0	0	0	0	0	0	0	0	0	0	0	(104)
Cooled fraction													0 (105)
Intermittency factor	0	0	0	0	0	0	0	0	0	0	0	0	(106)
Space cooling requirement for month	0	0	0	0	0	0	0	0	0	0	0	0	(107)
Space cooling requirement in kWh/m ² /year													0 (108)

8f. Space heating requirement

Fabric Energy Efficiency,													0 (109)
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9b. Energy requirements – Heat networks



Page 6

DER WORKSHEET



DER WORKSHEET

Fraction Of space heat from secondary/supplementary heating	0	(301)
Fraction Of space heat from heat network	1	(302)
Where the heat network is Not listed in the PCDB:	0	
Fraction of heat from CHP	1	(303a)
Fraction of heat from heat source 2	0	(303b)
Fraction of heat from heat source 3	0	(303c)
Fraction of heat from heat source 4	0	(303d)
Fraction of heat from heat source 5	0	(303e)
Whether the heat network is listed in the PCDB or not:	0	
Factor for control and charging method (Table 4c(3)) for space heating	1.05	(305)
Factor for charging method (Table 4c(3)) for water heating	1	(305a)
Distribution loss factor (Table 12c) for heat network - set to 1 if HN listed in PCDB	1.1	(306)
Annual space heating requirement		
Heat required from heat network		
Where the heat network is not listed in the PCDB:		
Space heat from CHP	703.31	(307a)
Space heat from heat source 2	0	(307b)
Space heat from heat source 3	0	(307c)
Space heat from heat source 4	0	(307d)
Space heat from heat source 5	0	(307e)
Whether the heat network is listed in the PCDB or not:		(302)
Efficiency of secondary/supplementary heating system in %	0	(308)
Space heating fuel for secondary/supplementary system	0	(309)
Water heating		
Annual water heating requirement		
If DHW from heat network:		
Heat required from heat network	0	(310)
Where the heat network is not listed in the PCDB:		
Water heat from CHP	2256.99	(310a)
Water heat from heat source 2	0	(310b)
Water heat from heat source 3	0	(310c)
Water heat from heat source 4	0	(310d)
Water heat from heat source 5	0	(310e)
If DHW by immersion or instantaneous heater within dwelling:		
Efficiency of water heater	0	(311)
Water heated by immersion or instantaneous heater	0	(312)
Electricity used for instantaneous electric shower(s)	0	(312a)
Electrical pumping energy as proportion of heat supplied	0	(313a)
Electricity used for heat distribution	29.6	(313)
Cooling System Seasonal Energy Efficiency Ratio	0	(314)
Space cooling (if there is a fixed cooling system	0	(315)
Electricity for pumps and fans within dwelling		



Page 7

DER WORKSHEET



DER WORKSHEET

mechanical ventilation - balanced, extract or positive input from outside														123.3	(330a)
warm air heating system fans														0	(330b)
pump for solar water heating														0	(330g)
pump for storage WWHRS (see section G3.3)														0	(330h)
electricity use by heat interface unit														0	(330i)
Total electricity for pumps and fans														123.3	(331)
Electricity for lighting (calculated in Appendix L)														415.34	(332)
Energy generation (Appendix M, negative quantity) - Energy used in dwelling															
PV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(333a)
Wind	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(334a)
Hydro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(335a)
Energy generation (Appendix M, negative quantity) - Energy used exported															
PV	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(333b)
Wind	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(334b)
Hydro	0	0	0	0	0	0	0	0	0	0	0	0	0	0	(335b)
Appendix Q items: annual energy														0	
energy saved														0	(336b)
energy used														0	(337b)
Total delivered energy for all uses														3498.94	

10b. Fuel costs – Individual heating systems including micro-CHP

Where the heat network is not listed in the PCDB:				
Fuel required	kWh/year	Fuel price	Fuel cost £/year	
Space heating from CHP	0		31.23	(340a)
Space heating from heat source 2	0		0	(340b)
Space heating from heat source 3	0		0	(340c)
Space heating from heat source 4	0		0	(340d)
Space heating from heat source 5	0		0	(340e)
Where the heat network is not listed in the PCDB:				
Space heating from PCDB heat network	0		4.44	(340)
Space heating fuel for secondary/supplementary system	0		0	(341)
If DHW from heat network:				
Where the heat network is Not listed in the PCDB:				
Water heating from CHP	0		100.21	(342a)
Water heating from heat source 2	0		0	(342b)
Water heating from heat source 3	0		0	(342c)
Water heating from heat source 4	0		0	(342d)
Water heating from heat source 5	0		0	(342e)
Water heating from PCDB heat network			4.44	(342)
If water heated by immersion heater:				
High-rate fraction (Table 13)	0		0	(343)



Page 8

DER WORKSHEET



DER WORKSHEET

Low-rate fraction	0	0	(344)
High-rate cost, or cost for single immersion	0	0	(345)
Low-rate cost	0	0	(346)
If water heated by instantaneous water heater	0	0	(347)
Energy used by instantaneous electric shower(s)	0	0	(347a)
Space cooling	0	0	(348)
Pumps and fans	0	20.33	(349)
Electricity for lighting	0	68.49	(350)
Additional standing charges (Table 12)		92	(351)
energy saved or generated		0	
energy saved	0	0	(353)
energy used	0	0	(354)
Total energy cost	0	312.26	(355)

11b. SAP SAP rating – Heat networks

Energy cost deflator		0.36	(356)
Energy cost factor (ECF)		1.2	(357)
SAP rating		80.61	(358)

12b. CO2 emissions – Individual heating systems

Where the heat network is not listed in the PCDB

CO2 from CHP (space and water heating):

Power efficiency of CHP unit (e.g. 25%)		0	(361)
Heat efficiency of CHP unit (e.g. 50%)		0	(362)

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year
Space heating from CHP			0 (363)
less credit emissions for electricity			0 (364)
Water heated by CHP			0 (365)
less credit emissions for electricity			0 (366)
CO2 from other sources of space and water heating (not CHP):			
Efficiency of heat source 2 (%)			0 (367b)
Efficiency of heat source 3 (%)			0 (367c)
Efficiency of heat source 4 (%)			0 (367d)
Efficiency of heat source 5 (%)			0 (367e)
CO2 associated with heat source 2			0 (368)
CO2 associated with heat source 3			0 (369)
CO2 associated with heat source 4			0 (370)
CO2 associated with heat source 5			0 (371)



Page 9

DER WORKSHEET



DER WORKSHEET

Where the heat network is listed in the PCDB:

Space and water heating supplied by heat network

Where the heat network is listed in the PCDB:

	Energy used KWh/year	Emission factor from PCDB	CO2/year kgCO2/year
Electrical energy for heat distribution			4.28 (372)
Total CO2 associated with heat networks			195.09 (373)
Space heating (secondary)			0 (374)
Water heating by immersion heater or instantaneous heater			0 (375)
Energy used by instantaneous electric shower(s)			0 (375a)
Total CO2 associated with space and water heating			195.09 (376)
Space cooling			0 (377)
Electricity for pumps and fans within dwelling			17.1 (378)
Electricity for lighting			59.95 (379)
energy saved or generated			(380)
energy saved or generated			
Appendix Q items			
energy saved			0 (381)
energy used			0 (382)
energy used			272.14 (383)
Total CO2, kg/year			5.55 (384)
EI rating (section 14)			96.12 (385)
Overall CO2 factor for heat network			0.07 (386)

13b. Primary Energy – Individual heating systems including micro-CHP

Where the heat network is not listed in the PCDB

CO2 from CHP (space and water heating):

Power efficiency of CHP unit (e.g. 25%)		0	(461)
Heat efficiency of CHP unit (e.g. 50%)		0	(462)

	Energy kWh/year	Emission factor from table 12	CO2/year kgCO2/year
Space heating from CHP			0 (463)
less credit emissions for electricity			0 (464)
Water heated by CHP			0 (465)
less credit emissions for electricity			0 (466)
CO2 from other sources of space and water heating (not CHP):			
Efficiency of heat source 2 (%)			0 (467b)
Efficiency of heat source 3 (%)			0 (467c)
Efficiency of heat source 4 (%)			0 (467d)
Efficiency of heat source 5 (%)			0 (467e)



Page 10

DER WORKSHEET



DER WORKSHEET

CO2 associated with heat source 2		0	(468)
CO2 associated with heat source 3		0	(469)
CO2 associated with heat source 4		0	(470)
CO2 associated with heat source 5		0	(471)
Where the heat network is listed in the PCDB:			
Space and water heating supplied by heat network	Energy used kWh/year	Emission factor from PCDB	CO2/year kgCO2/year
			0 (371a)
Electrical energy for heat distribution			45.44 (472)
Total CO2 associated with heat networks			2151.32 (473)
Space heating (secondary)			0 (474)
Water heating by immersion heater or instantaneous heater			0 (475)
Energy used by instantaneous electric shower(s)			0 (475a)
Total CO2 associated with space and water heating			2151.32 (476)
Space cooling			0 (477)
Electricity for pumps and fans within dwelling			186.52 (478)
Electricity for lighting			637.07 (479)
energy saved or generated			
energy saved or generated	0		0 (480)
Appendix Q items			
energy saved	0		0 (481)
energy used			0 (482)
Total CO2, kg/year			2974.91 (383)
Dwelling CO2 Emission Rate			60.71 (274)
Overall CO2 factor for heat network			0.73 (386)



Page 11

DER WORKSHEET

Sample SAP Unit B2112 – Demand Reduction



DER WORKSHEET

Dwelling Reference: B2112
Dwelling Type: New Dwelling Design Stage
Eaton Court
Oxford Road
READING
RG1 7FU

1. Overall dwelling dimensions

	Area(m²)	Av. Height(m)	Volume(m³)
Ground Floor	46 (1a) x 2.75	(2a) =	126.5 (3a)
Total floor area TFA			46 (4)
Dwelling volume			126.5 (5)

2. Ventilation Rate

Chimneys/Flues	0	x 80 =	0 (6a)
Open chimneys	0	x 20 =	0 (6b)
Chimneys / flues attached to closed fire	0	x 10 =	0 (6c)
Flues attached to solid fuel boiler	0	x 20 =	0 (6d)
Flues attached to other heater	0	x 35 =	0 (6e)
Number of blocked chimneys	0	x 20 =	0 (6f)
Number of intermittent extract 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

Number of storeys in the dwelling (ns)	0	0 (8)
Infiltration due to chimneys, flues, fans, PSVs, etc	0	0 (9)
Additional infiltration	0	0 (10)
Structural infiltration	0	0 (11)
Suspended wooden ground floor	0	0 (12)
No draught lobby	0	0 (13)
Percentage of windows and doors draught proofed	0	0 (14)
Window infiltration	0	0 (15)
Infiltration rate	0	0 (16)
Air permeability value, AP50, (m³/h/m²)	2	2 (17)
Air permeability value, AP4, (m³/h/m²)	0	0 (17a)
Air permeability value)	0.1	0.1 (18)
Number of sides on which dwelling is sheltered	3	3 (19)
Shelter factor		0.78 (20)



DER WORKSHEET

Page 1



DER WORKSHEET

Infiltration rate incorporating shelter factor 0.08 (21)
Infiltration rate modified for monthly wind speed

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5 (22)

Monthly average wind speed from Table U2
Wind Factor 1.28 1.25 1.23 1.1 1.08 0.95 0.95 0.93 1 1.08 1.13 1.18 13.13 (22a)
Adjusted infiltration rate (allowing for shelter and wind speed) 0.1 0.1 0.09 0.09 0.08 0.07 0.07 0.07 0.08 0.08 0.09 0.09 1.02 (22b)
Calculate effective air change rate for the applicable case:
0.5 (23a)
0.5 (23b)
45 (23c)
a) If balanced mechanical ventilation with heat recovery (MVHR) 0.37 0.37 0.37 0.36 0.36 0.35 0.35 0.35 0.35 0.36 0.36 0.37 (24a)
b) If balanced mechanical ventilation without heat recovery (MV) 0 0 0 0 0 0 0 0 0 0 0 0 (24b)
c) If whole house extract ventilation or positive input ventilation from outside 0 0 0 0 0 0 0 0 0 0 0 0 (24c)
d) If natural ventilation or whole house positive input ventilation from loft 0 0 0 0 0 0 0 0 0 0 0 0 (24d)
Effective air change rate 0.37 0.37 0.37 0.36 0.36 0.35 0.35 0.35 0.35 0.36 0.36 0.37 (25)
Effective air change rate from PCDB: 0.37 0.37 0.37 0.36 0.36 0.35 0.35 0.35 0.35 0.36 0.36 0.37 (25)

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k-value

ELEMENT	Gross area (m²)	Openings m²	Net Area A _n ,m²	U-value W/m²K	A X U (W/K)	k-value kJ/m².K	A X k
Solid door						0	0 (26)
Semi-glazed door						0	0 (26a)
Window						6.8	0 (27)
Roof window						0	0 (27a)
Basement floor				0		0	0 (28)
Ground floor				0		0	0 (28a)
Exposed floor				3450		5.52	0 (28b)
Basement wall				0		0	0 (29)
External wall				774		0.77	0 (29a)
Roof				0		0	0 (30)



DER WORKSHEET

Page 2



DER WORKSHEET

Total area of external elements ΣA, m² 57.1 (31)
Party Wall 0 (32)
Party floor 0 (32a)
Party ceiling 0 (32b)
Internal wall ** 0 (33c)
Internal floor 0 (32d)
Internal ceiling floor 0 (32e)
Fabric heat loss, W/K = Σ (A x U) 13.1 (33)
Heat capacity Cm = Σ(A x k) 4959 (34)
Thermal mass parameter (TMP = Cm + TFA) in kJ/m³K 250 (35)
Linear Thermal bridges: Σχ (L x Ψ) calculated using Appendix K 2.86 (36)
Point Thermal bridges: Σχ (W/K) if significant point thermal bridge present and values available 2.86 (36a)
Total fabric heat loss H = Σ(A x U) + Σ(L x Ψ) + Σχ 15.95 (37)
Ventilation heat loss calculated monthly
15.6 15.52 15.44 15.04 14.96 14.55 14.55 14.47 14.72 14.96 15.12 15.28 (38)
Heat transfer coefficient, W/K
31.56 31.47 31.39 30.99 30.91 30.5 30.5 30.42 30.67 30.91 31.07 31.23 (39)
Heat loss parameter (HLP), W/m²K
0.69 0.68 0.68 0.67 0.67 0.66 0.66 0.67 0.67 0.68 0.68 (40)
Number of days in month (Table 1a)
31 28 31 30 31 30 31 31 30 31 30 31 (41)

4. Water heating energy requirement

Assumed occupancy, N 1.57 (42)
Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)
0 0 0 0 0 0 0 0 0 0 0 0 (42a)
Hot water usage in litres per day for baths, Vd,bath (from Appendix J)
58.27 57.41 56.19 53.94 52.26 50.39 49.39 50.6 51.91 53.91 56.2 58.08 (42b)
Hot water usage in litres per day for other uses, Vd,other (from Appendix J)
30.74 29.62 28.51 27.39 26.27 25.15 25.15 26.27 27.39 28.51 29.62 30.74 (42c)
Annual average hot water usage in litres per day Vd,average (from Appendix J) 81.98 (43)
Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)
89.02 87.03 84.7 81.33 78.53 75.55 74.54 76.87 79.3 82.42 85.83 88.82 983.94 (44)
Energy content of hot water used = 4.18 x Vd,m x nm x DTm / 3600 kWh/month (from Appendix J)
140.98 123.94 130.18 111.34 105.72 92.89 90.15 95.18 97.79 111.84 122.28 139.07 1361.36 (45)
Distribution loss (46) = 0.15 x (45)
21.15 18.59 19.53 16.7 15.86 13.93 13.52 14.28 14.67 16.78 18.34 20.86 (46)
Storage volume (litres) including any solar or WWHRs storage within same vessel 0 (47)
Water storage loss (or HIU loss)
a) If manufacturer's declared loss factor is known (kWh/day): 0 (48)



DER WORKSHEET

Page 3

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7. Mean internal temperature (heating season)													
Temperature during heating periods in the living area from Table 9, Th1 (°C)											21	(85)	
Utilisation factor for gains for living area, $\xi_{l,m}$ (see Table 9a)													
	0.98	0.97	0.94	0.85	0.69	0.49	0.36	0.38	0.59	0.86	0.96	0.99	(86)
Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)													
	20.55	20.65	20.78	20.92	20.99	21	21	21	21	20.93	20.74	20.54	(87)
Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)													
	20.35	20.35	20.36	20.36	20.37	20.37	20.37	20.38	20.37	20.37	20.36	20.36	(88)
Roof	Utilisation factor for gains for rest of dwelling, $\xi_{2,m}$ (see Table 9a)												
	0.98	0.96	0.93	0.82	0.65	0.45	0.3	0.33	0.54	0.82	0.95	0.98	(89)
Roof	Mean internal temperature in the rest of dwelling T2												
	19.96	20.05	20.17	20.31	20.36	20.37	20.37	20.38	20.37	20.32	20.14	19.94	(90)
Living area fraction											0.65	(91)	
Mean internal temperature [for the whole dwelling]													
	20.35	20.45	20.57	20.71	20.77	20.78	20.78	20.78	20.78	20.72	20.53	20.33	(92)
Adjusted mean internal temperature:													
	20.35	20.45	20.57	20.71	20.77	20.78	20.78	20.78	20.78	20.72	20.53	20.33	(93)

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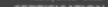



Page 7
 DER WORKSHEET




DER WORKSHEET
Page 8




Page 9



DER WORKSHEET

Space and water heating		441.48	(265)
Space cooling		0	(266)
Electricity for pumps, fans and electric keep		27.98	(267)
Electricity for lighting		44.65	(268)
energy saved or generated	0	0	(269b)
Appendix Q items			
energy saved	0	0	
energy used	0	0	
energy saved	0	0	(270b)
energy used	0	0	(271b)
Total CO ₂ , kg/year		514.11	(272)
Dwelling CO ₂ Emission Rate		11.18	(273)
EI rating		92	(274)

13a. Primary Energy – Individual heating systems including micro-CHP

	Energy KWh/year	Emission factor kg	Emissions kg CO ₂ /year	
Space heating - main system 1			680.36	(275)
Space heating - main system 2			0	(276)
Space heating - secondary			0	(277)
Energy for water heating			3477.02	(278)
Energy for instantaneous electric shower(s)			0	(278a)
Space and water heating			4157.39	(279)
Space cooling			0	(280)
Electricity for pumps, fans and electric keep			305.2	(281)
Electricity for lighting			474.5	(282)
energy saved or generated	0		0	
Appendix Q items				
energy saved	0		0	
energy used	0		0	
energy saved	0		0	(284b)
energy used			0	(285b)
Total PE, kWh/year			4937.08	(286)
Dwelling PE Rate			107.33	(287)



DER WORKSHEET

Page 10



DER WORKSHEET

Dwelling Reference: B2112
Dwelling Type: New Dwelling Design Stage
Eaton Court
Oxford Road
READING
RG1 7FU

1. Overall dwelling dimensions

	Area(m ²)	Av. Height(m)	Volume(m ³)
Ground Floor	46 { 1a) x 2.75	(2a) =	126.5 { 3a)
Total floor area TFA			46 { 4)
Dwelling volume			126.5 { 5)

2. Ventilation Rate

Chimneys/Flues	0	x 80 =	0	(6a)
Open chimneys	0	x 20 =	0	(6b)
Chimneys / flues attached to closed fire	0	x 10 =	0	(6c)
Flues attached to solid fuel boiler	0	x 20 =	0	(6d)
Flues attached to other heater	0	x 35 =	0	(6e)
Number of blocked chimneys	0	x 20 =	0	(6f)
Number of intermittent extract 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				
Number of storeys in the dwelling (ns)		0	0	(8)
Infiltration due to chimneys, flues, fans, PSVs, etc		0	0	(9)
Additional infiltration		0	0	(10)
Structural infiltration		0	0	(11)
Suspended wooden ground floor		0	0	(12)
No draught lobby		0	0	(13)
Percentage of windows and doors draught proofed		0	0	(14)
Window infiltration		0	0	(15)
Infiltration rate		0	0	(16)
Air permeability value, APS0, (m ³ /h/m ²)		2	2	(17)
Air permeability value, AP4, (m ³ /h/m ²)		0	0	(17a)
Air permeability value)		0.1	0.1	(18)
Number of sides on which dwelling is sheltered		3	3	(19)
Shelter factor			0.78	(20)



DER WORKSHEET

Page 1



DER WORKSHEET

Infiltration rate incorporating shelter factor 0.08 (21)

Infiltration rate modified for monthly wind speed

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

(22)

Monthly average wind speed from Table U2

5.1	5	4.9	4.4	4.3	3.8	3.8	3.7	4	4.3	4.5	4.7	52.5
-----	---	-----	-----	-----	-----	-----	-----	---	-----	-----	-----	------

(22)

Wind Factor

1.28	1.25	1.23	1.1	1.08	0.95	0.95	0.93	1	1.08	1.13	1.18	13.13
------	------	------	-----	------	------	------	------	---	------	------	------	-------

(22a)

Adjusted infiltration rate (allowing for shelter and wind speed)

0.1	0.1	0.09	0.09	0.08	0.07	0.07	0.07	0.08	0.08	0.09	0.09	1.02
-----	-----	------	------	------	------	------	------	------	------	------	------	------

(22b)

Calculate effective air change rate for the applicable case:

0.5	(23a)
-----	-------

0.5	(23b)
-----	-------

45	(23c)
----	-------

a) If balanced mechanical ventilation with heat recovery (MVHR)

0.37	0.37	0.37	0.36	0.36	0.35	0.35	0.35	0.35	0.36	0.36	0.37	(24a)
------	------	------	------	------	------	------	------	------	------	------	------	-------

b) If balanced mechanical ventilation without heat recovery (MV)

0	0	0	0	0	0	0	0	0	0	0	0	(24b)
---	---	---	---	---	---	---	---	---	---	---	---	-------

c) If whole house extract ventilation or positive input ventilation from outside

0	0	0	0	0	0	0	0	0	0	0	0	(24c)
---	---	---	---	---	---	---	---	---	---	---	---	-------

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

0	0	0	0	0	0	0	0	0	0	0	0	(24d)
---	---	---	---	---	---	---	---	---	---	---	---	-------

Effective air change rate

0.37	0.37	0.37	0.36	0.36	0.35	0.35	0.35	0.35	0.36	0.36	0.37	(25)
------	------	------	------	------	------	------	------	------	------	------	------	------

Effective air change rate from PCDB:

0.37	0.37	0.37	0.36	0.36	0.35	0.35	0.35	0.35	0.36	0.36	0.37	(25)
------	------	------	------	------	------	------	------	------	------	------	------	------

3. Heat losses and heat loss parameter

Items in the table below are to be expanded as necessary to allow for all different types of element e.g. 4 wall types. The k-value

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
Solid door						0	(26)
Semi-glazed door						0	(26a)
Window						6.8	(27)
Roof window						0	(27a)
Basement floor				0		0	(28)
Ground floor				0		0	(28a)
Exposed floor				3450		5.52	(28b)
Basement wall				0		0	(29)
External wall				774		0.77	(29a)
Roof				0		0	(30)



DER WORKSHEET

Page 2



DER WORKSHEET

Total area of external elements $\sum A$, m ²	57.1	(31)
Party Wall	0	(32)
Party floor	0	(32a)
Party ceiling	0	(32b)
Internal wall **	0	(33c)
Internal floor	0	(32d)
Internal ceiling floor	0	(32e)
Fabric heat loss, W/K = $\sum (A \times U)$	13.1	(33)
Heat capacity Cm = $\sum (A \times k)$	4959	(34)
Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m ² K	250	(35)
Linear Thermal bridges: $\sum (L \times \Psi)$ calculated using Appendix K	2.86	(36)
Point Thermal bridges: $\sum \chi$ (W/K) if significant point thermal bridge present and values available	2.86	(36a)
Total fabric heat loss H = $\sum (A \times U) + \sum (L \times \Psi) + \sum \chi$	15.95	(37)
Ventilation heat loss calculated monthly		
15.6 15.52 15.44 15.04 14.96 14.55 14.55 14.47 14.72 14.96 15.12 15.28		(38)
Heat transfer coefficient, W/K		
31.56 31.47 31.39 30.99 30.91 30.5 30.5 30.42 30.67 30.91 31.07 31.23		(39)
Heat loss parameter (HLP), W/m ² K		
0.69 0.68 0.68 0.67 0.67 0.66 0.66 0.66 0.67 0.67 0.68 0.68		(40)
Number of days in month (Table 1a)		
31 28 31 30 31 30 31 31 30 31 30 31		(41)

4. Water heating energy requirement

Assumed occupancy, N	1.57	(42)
Hot water usage in litres per day for mixer showers, Vd,shower (from Appendix J)		
0 0 0 0 0 0 0 0 0 0 0 0		(42a)
Hot water usage in litres per day for baths, Vd,bath (from Appendix J)		
58.27 57.41 56.19 53.94 52.26 50.39 49.39 50.6 51.91 53.91 56.2 58.08		(42b)
Hot water usage in litres per day for other uses, Vd,other (from Appendix J)		
30.74 29.62 28.51 27.39 26.27 25.15 25.15 26.27 27.39 28.51 29.62 30.74		(42c)
Annual average hot water usage in litres per day Vd,average (from Appendix J)	81.98	(43)
Hot water usage in litres per day for each month Vd,m = (42a) + (42b) + (42c)		
89.02 87.03 84.7 81.33 78.53 75.55 74.54 76.87 79.3 82.42 85.83 88.82	983.94	(44)
Energy content of hot water used = $4.18 \times Vd,m \times \rho \times DTm / 3600$ kWh/month (from Appendix J)		
140.98 123.94 130.18 111.34 105.72 92.89 90.15 95.18 97.79 111.84 122.28 139.07	1361.36	(45)
Distribution loss (46) = $0.15 \times (45)$		
21.15 18.59 19.53 16.7 15.86 13.93 13.52 14.28 14.67 16.78 18.34 20.86		(46)
Storage volume (litres) including any solar or WWHRs storage within same vessel	0	(47)
Water storage loss (or HIU loss)		
a) If manufacturer's declared loss factor is known (kWh/day):	0	(48)



DER WORKSHEET

Page 3



DER WORKSHEET

Temperature factor from Table 2b	0	(49)
Energy lost from water storage, kWh/day (48) x (49) =	110	(50)
b) If manufacturer's declared loss factor is not known :		
Hot water storage loss factor from Table 2 (kWh/litre/day)	0.02	(51)
Volume factor from Table 2a	1.03	(52)
Temperature factor from Table 2b	0.6	(53)
Energy lost from water storage, kWh/day	1.03	(54)
Enter (50) or (54) in (55)	1.03	(55)
Water storage (or HIU) loss calculated for each month (56) = (55) x (41)		
32.01 28.92 32.01 30.98 32.01 30.98 32.01 32.01 30.98 32.01 30.98 32.01		(56)
If the vessel contains dedicated solar storage or dedicated WWHRs storage, (57)m = (56)m $\div [(47) - Vs] \div (47)$, else (57)m = (56)m where Vs is Vvw from Appendix G3 or (H12) from Appendix H (as applicable).		
32.01 28.92 32.01 30.98 32.01 30.98 32.01 32.01 30.98 32.01 30.98 32.01		(57)
Primary circuit loss for each month from Table 3		
modified by factor from Table H4 if there is solar water heating and a cylinder thermostat, although not for DHW-only heat networks)		
23.26 21.01 23.26 22.51 23.26 22.51 23.26 23.26 22.51 23.26 22.51 23.26		(59)
Combi loss for each month from Table 3a, 3b or 3c (enter 0 if not a combi boiler)		
0 0 0 0 0 0 0 0 0 0 0 0		(61)
Total heat required for water heating calculated for each month (62) = $0.85 \times (45) + (46) + (57) + (59) + (61)$		
196.26 173.86 185.45 164.83 161 146.39 145.43 150.46 151.28 167.12 175.77 194.35	2012.2	(62)
CWWHRs DHW input calculated using Appendix G (negative quantity) (enter 0 if no WWHRs contribution to water heating)		
0 0 0 0 0 0 0 0 0 0 0 0		(63a)
PV diverter DHW input calculated using Appendix G (negative quantity) (enter 0 if no PV diverter contribution)		
0 0 0 0 0 0 0 0 0 0 0 0		(63b)
Solar DHW input calculated using Appendix H (negative quantity) (enter 0 if no solar contribution to water heating)		
0 0 0 0 0 0 0 0 0 0 0 0		(63c)
FGHRs DHW input calculated using Appendix G (negative quantity) (enter 0 if no FGHRs contribution to water heating)		
0 0 0 0 0 0 0 0 0 0 0 0		(63d)
Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)		
196.26 173.86 185.45 164.83 161 146.39 145.43 150.46 151.28 167.12 175.77 194.35	2012.2	(64)
Output from water heater for each month, kWh/month (64) = (62) + (63a) + (63b) + (63c) + (63d)		
0 0 0 0 0 0 0 0 0 0 0 0		(64a)
Heat gains from water heating, kWh/month $0.25 \times [0.85 \times (45) + (61) + (64a)] + 0.8 \times [(46) + (57) + (59)]$		
91.1 81.15 87.51 79.82 79.37 73.68 74.2 75.87 75.31 81.41 83.45 90.46		(65)
include (57) m in calculation of (65) m only if hot water store is in the dwelling or hot water is from heat network		

5. Internal gains (see Tables 5 and 5a)

Metabolic gains (Table 5), watts		
78.67 78.67 78.67 78.67 78.67 78.67 78.67 78.67 78.67 78.67 78.67 78.67		(66)



DER WORKSHEET

Page 4



DER WORKSHEET

Lighting gains (calculated in Appendix L, equation L12 or L12a), also see Table 5		
75.39 83.46 75.39 77.9 75.39 77.9 75.39 75.39 77.9 75.39 77.9 75.39		(67)
Appliances gains (calculated in Appendix L, equation L16 or L16a), also see Table 5		
136.86 138.28 134.7 127.08 117.47 108.43 102.39 100.97 104.55 112.17 121.78 130.82		(68)
Cooking gains (calculated in Appendix L, equation L18 or L18a), also see Table 5		
30.87 30.87 30.87 30.87 30.87 30.87 30.87 30.87 30.87 30.87 30.87 30.87		(69)
Pumps and fans gains (Table 5a)		
0 0 0 0 0 0 0 0 0 0 0 0		(70)
Losses e.g. evaporation (negative values) (Table 5)		
-62.93 -62.93 -62.93 -62.93 -62.93 -62.93 -62.93 -62.93 -62.93 -62.93 -62.93		(71)
Water heating gains (Table 5)		
122.44 120.76 117.61 110.85 106.68 102.34 99.73 101.97 104.6 109.42 115.91 121.59		(72)
Total internal gains		
381.29 389.1 374.3 362.44 346.14 335.26 324.1 324.93 333.64 343.57 362.19 374.4		(73)

6. Solar gains

Solar gains in watts, calculated for each month		
17.83 34.87 57.43 83.76 102.65 105.08 100.04 85.93 66.79 41.38 22.23 14.66		(83)
Total gains – internal and solar (watts)		
399.12 423.98 431.74 446.2 448.79 440.34 424.14 410.86 400.44 384.95 384.42 389.06		(84)

7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C)	21	(85)
Utilisation factor for gains for living area, $\varnothing_{L,m}$ (see Table 9a)		
0.97 0.95 0.91 0.8 0.63 0.44 0.32 0.34 0.53 0.79 0.93 0.97		(86)
Mean internal temperature in living area T1 (follow steps 3 and 4 in Table 9c)		
20.64 20.73 20.84 20.95 20.99 21 21 21 21 20.96 20.81 20.63		(87)
Temperature during heating periods in rest of dwelling from Table 9, Th2 (°C)		
20.35 20.35 20.36 20.36 20.37 20.37 20.37 20.38 20.37 20.37 20.36 20.36		(88)
Roof Utilisation factor for gains for rest of dwelling, $\varnothing_{2,m}$ (see Table 9a)		
0.96 0.94 0.89 0.77 0.59 0.4 0.27 0.29 0.48 0.76 0.92 0.97		(89)
Roof Mean internal temperature in the rest of dwelling T2		
20.04 20.13 20.23 20.33 20.36 20.37 20.37 20.38 20.37 20.34 20.21 20.03		(90)
Living area fraction	0.65	(91)
Mean internal temperature (for the whole dwelling)		
20.43 20.52 20.63 20.73 20.77 20.78 20.78 20.78 20.78 20.74 20.6 20.42		(92)
Adjusted mean internal temperature:		
20.43 20.52 20.63 20.73 20.77 20.78 20.78 20.78 20.78 20.74 20.6 20.42		(93)

8. Space heating requirement



DER WORKSHEET

Page 5



8c. Space Cooling requirement

8f. Space heating requirement

9b. Energy requirements – Heat networks



DER WORKSHEET

10b. Fuel costs – Individual heating systems including micro-CHPDER WORKSHEET



DER WORKSHEET

Low-rate fraction	0	0	(344)
High-rate cost, or cost for single immersion	0	0	(345)
Low-rate cost	0	0	(346)
If water heated by instantaneous water heater	0	0	(347)
Energy used by instantaneous electric shower(s)	0	0	(347a)
Space cooling	0	0	(348)
Pumps and fans	0	19.09	(349)
Electricity for lighting	0	51.01	(350)
Additional standing charges (Table 12)		92	(351)
energy saved or generated		0	
energy saved	0	0	(353)
energy used	0	0	(354)
Total energy cost	0	279.1	(355)

11b. SAP rating – Heat networks

Energy cost deflator	0.36	(356)
Energy cost factor (ECF)	1.1	(357)
SAP rating	82.1	(358)

12b. CO2 emissions – Individual heating systems

Where the heat network is not listed in the PCDB

CO2 from CHP (space and water heating):

Power efficiency of CHP unit (e.g. 25%)	0	(361)
Heat efficiency of CHP unit (e.g. 50%)	0	(362)

	Energy KWh/year	Emission factor kg	Emissions kg CO2/year	
Space heating from CHP			0	(363)
less credit emissions for electricity			0	(364)
Water heated by CHP			0	(365)
less credit emissions for electricity			0	(366)
CO2 from other sources of space and water heating (not CHP):				
Efficiency of heat source 2 (%)			0	(367b)
Efficiency of heat source 3 (%)			0	(367c)
Efficiency of heat source 4 (%)			0	(367d)
Efficiency of heat source 5 (%)			0	(367e)
CO2 associated with heat source 2			0	(368)
CO2 associated with heat source 3			0	(369)
CO2 associated with heat source 4			0	(370)
CO2 associated with heat source 5			0	(371)



DER WORKSHEET

Page 9



DER WORKSHEET

Where the heat network is listed in the PCDB:	Energy used kWh/year	Emission factor from PCDB	CO2/year kgCO2/year	
Space and water heating supplied by heat network			0	(371a)
Where the heat network is listed in the PCDB:	Energy used KWh/year	Emission factor from PCDB	CO2/year kgCO2/year	
Electrical energy for heat distribution			3.78	(372)
Total CO2 associated with heat networks			173.63	(373)
Space heating (secondary)			0	(374)
Water heating by immersion heater or instantaneous heater			0	(375)
Energy used by instantaneous electric shower(s)			0	(375a)
Total CO2 associated with space and water heating			173.63	(376)
Space cooling			0	(377)
Electricity for pumps and fans within dwelling			16.06	(378)
Electricity for lighting			44.65	(379)
energy saved or generated				
energy saved or generated				(380)
Appendix Q items				
energy saved			0	(381)
energy used			0	(382)
energy used			234.34	(383)
Total CO2, kg/year			5.09	(384)
EI rating (section 14)			96.55	(385)
Overall CO2 factor for heat network			0.07	(386)

13b. Primary Energy – Individual heating systems including micro-CHP

Where the heat network is not listed in the PCDB

CO2 from CHP (space and water heating):

Power efficiency of CHP unit (e.g. 25%)	0	(461)
Heat efficiency of CHP unit (e.g. 50%)	0	(462)

	Energy kWh/year	Emission factor from table 12	CO2/year kgCO2/year	
Space heating from CHP			0	(463)
less credit emissions for electricity			0	(464)
Water heated by CHP			0	(465)
less credit emissions for electricity			0	(466)
CO2 from other sources of space and water heating (not CHP):				
Efficiency of heat source 2 (%)			0	(467b)
Efficiency of heat source 3 (%)			0	(467c)
Efficiency of heat source 4 (%)			0	(467d)
Efficiency of heat source 5 (%)			0	(467e)



DER WORKSHEET

Page 10