# CAMBRIDGE ROAD ESTATE – PLANNING APPLICATION 20/02942/FUL

# ENERGY STATEMENT - NOVEMBER 2020

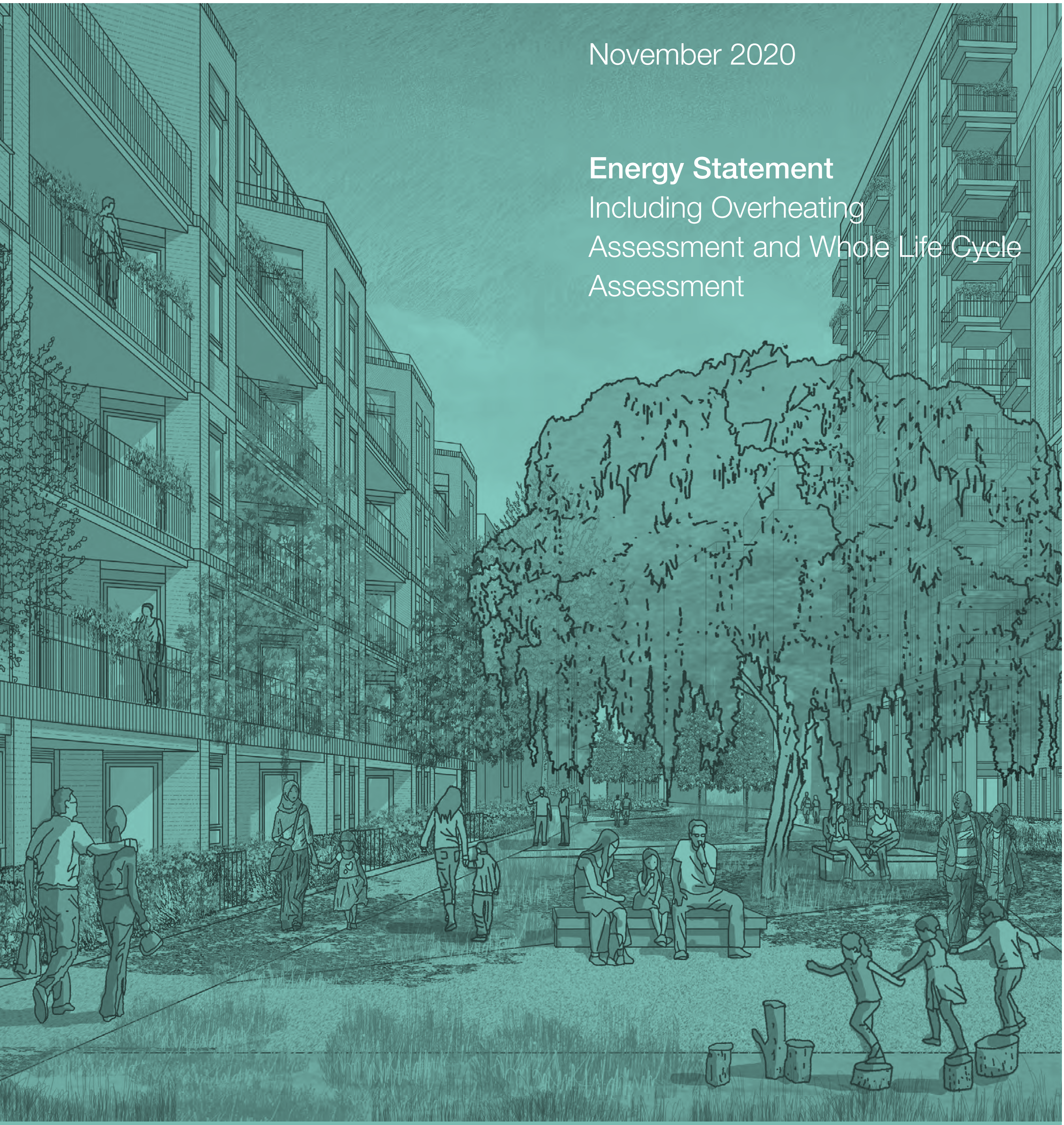
****NOTE WHOLE LIFE CYCLE ASSESSMENT THAT WAS ORIGINALLY INCLUDED IN THE ENERGY STATEMENT HAS BEEN UPDATED IN OCTOBER 2021****

Patel Taylor

# Cambridge Road Estate
Hybrid Planning Application

November 2020

## Energy Statement
Including Overheating Assessment and Whole Life Cycle Assessment



CRE
CAMBRIDGE ROAD ESTATE

COUNTRYSIDE
Places People Love

THE ROYAL BOROUGH OF
KINGSTON UPON THAMES

# The Applicant

**Cambridge Road (Kingston) Ltd**

c/o Countryside Properties
Aurora House
71-75 Uxbridge Road
Ealing
London W5 5SL

# The project site

**Cambridge Road Estate**
**Project hub**

2 Tadlow
Washington Road
Kingston Upon Thames
Surrey
KT1 3JL

# Application forms

Covering letter

Application Form and Notices

CIL Additional Information Form

# Design proposals

Planning Statement

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Draft Estate Management Strategy

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Phase 1 Travel Plan
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Servicing and Delivery Management Plan

Construction Logistics Plan
Construction Method Statement and Construction Management Plan
Sustainable Design and Construction Statement (Including Circular Economy Statement)

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Energy Statement (Including Overheating Assessment and Whole Life Cycle Assessment)

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External Assessment of the Illustrative Masterplan

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Noise Impact Assessment

Arboricultural Report and Tree Conditions Survey
Arboricultural Impact Assessment & Method Statement
Preliminary Ecological and Bat Survey Report
Biodiversity Net Gain Assessment

Archaeology and Heritage Assessment
Ground Conditions Assessment

Utilities Report

Flood Risk Assessment
Phase 1 Drainage Statement

Fire Strategy Report

Accessibility Audit
Health Impact Assessment
Equalities Impact Assessment

HODKINSON

Energy Statement

Cambridge Road (RBK) LLP

# Cambridge Road Estate

FINAL

**Nikhil Doshi**
Meng (Hons), CEng, MIMechE
October 2020

# Document Control Record
# Report Status: FINAL

| Version | Date | Reason for issue | Author | Checked by | Approved for Issue by Project Manager |
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| v.1 | 02/10/2020 | Draft | ND | DS | ND |
| v. 2 | 27/10/2020 | Final | ND | DS | ND |
| v. 3 | 13/11/2020 | Final minor comments | ND | DS | ND |

## About Hodkinson Consultancy

Our team of technical specialists offer advanced levels of expertise and experience to our clients. We have a wide experience of the construction and development industry and tailor teams to suit each individual project.

We are able to advise at all stages of projects from planning applications to handover.

Our emphasis is to provide innovative and cost-effective solutions that respond to increasing demands for quality and construction efficiency.

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# Executive Summary

The purpose of this Energy Statement is to demonstrate the commitments, key measures and $CO_2$ reductions identified at each stage of the energy strategy for the proposed Cambridge Road Estate development in the Royal Borough of Kingston Upon Thames.

This energy strategy has been formulated following the London Plan Energy Hierarchy: ***Be Lean***, ***Be Clean*** and ***Be Green***. The objective in the formulation of the strategy is to maximise the reductions in $CO_2$ emissions through the application of this Hierarchy with a cost-effective approach that is technically appropriate.

The development summarised in this application concerns:

> Hybrid Outline Planning Application for a mixed use development, including demolition of existing buildings and erection of up to 2,170 residential units (Use Class C3), 290 $m^2$ of flexible office floorspace (Use Class E), 1,395 $m^2$ of flexible retail/commercial floorspace (Use Class E/Sui Generis), 1,250 $m^2$ community floorspace (Use Class F2);

> Detailed permission is sought for access, layout, scale, appearance and landscaping of Phase 1 for erection of 452 residential units (Use Class C3), 1,250 $m^2$ community floorspace (Use Class F2), 290 $m^2$ of flexible office floorspace (Use Class E), 395 $m^2$ of flexible retail/commercial floorspace (Use Class E/Sui Generis), new publicly accessible open space and associated access, servicing, parking, landscaping works including tree removal, refuse/recycling and bicycle storage, energy centre and works.

Following an examination of both local and national policy requirements, it has been determined that the proposed development is to target a reduction in $CO_2$ emissions of 35% beyond a determined Part L 2013 baseline case on site. For the purposes of this Energy Statement the SAP 10.0 carbon factors are to be utilised.

A range of ***Be Lean*** energy efficiency measures are proposed for the dwellings and Non-residential areas. This is in line with the London Plan Energy Hierarchy. They enable the proposed elements to meet the 10% and 15% improvement required from the residential and non-residential baseline cases, respectively, through energy efficiency alone. They further achieve the proposed requirements of the Draft London Plan by meeting the targeted energy efficiency requirements for this stage.

In accordance with the Energy Hierarchy, the feasibility of heating infrastructure as a ***Be Clean*** measure has also been carefully examined. Following a site analysis, a site wide heating network with a plant room located at the base of Block E will be present. This is to enable the connection to the wider heat network that is being developed by the Royal Borough of Kingston Upon Thames. This heat network is expected to utilise heat pumps for heat generation. This development is intended to be the anchor site and is likely to be connected to this wider network. This achieves the onsite carbon reductions (35%) required by Policy SI 2 of the Intend to Publish new London Plan.

In accordance with the Energy Hierarchy, the relevant **Be Green** renewable energy generating technologies have been evaluated. In line with Policy SI 2 renewables have been maximised through the application of low carbon heating and where safely and practicably feasible, application of photovoltaics.

The proposed design for the development will enable it to reduce its $CO_2$ emissions and go beyond the requirements of the London Plan representing a high level of sustainable design.

The onsite carbon emission reductions required by the London Plan have been achieved. The remaining carbon emissions are described in Table 4.

The tables below demonstrate the reduction in Regulated and Total $CO_2$ reductions after each stage of the Energy Hierarchy showing energy policy requirements have been achieved. They are based on SAP 10.0 carbon factors.

**Table 1: Residential Carbon Dioxide Emissions and Savings after each stage of the Energy Hierarchy**

| **Stage** | **Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum)** | |
|---|---|---|
| | **Regulated** | **Unregulated** |
| Baseline: Part L 2013 Compliant Development | 2,148 | 1,225 |
| After *Be Lean* Measures | 1,860 | 1,225 |
| After *Be Clean* Measures | 839 | 1,225 |
| After *Be Green* Measures | 792 | 1,225 |
| **Stage** | **Regulated Carbon Dioxide Savings** | |
| | **Tonnes $CO_2$ per Annum** | **Percentage** |
| Savings from *Be Lean* Measures | 288 | 13% |
| Savings from *Be Clean* Measures | 1,021 | 48% |
| Savings from *Be Green* Measures | 46 | 2% |
| **Cumulative On-Site Savings** | **1,355** | 63% |

**Table 2: Non- Residential Carbon Dioxide Emissions and Savings after each stage of the Energy Hierarchy**

| **Stage** | **Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum)** | |
|---|---|---|
| | **Regulated** | **Unregulated** |
| Baseline: Part L 2013 Compliant Development | 33 | 7 |
| After *Be Lean* Measures | 26 | 7 |
| After *Be Clean* Measures | 26 | 7 |
| After *Be Green* Measures | 17 | 7 |
| **Stage** | **Regulated Carbon Dioxide Savings** | |
| | **Tonnes $CO_2$ per Annum** | **Percentage** |
| Savings from *Be Lean* Measures | 6 | 20% |
| Savings from *Be Clean* Measures | 0 | 0% |
| Savings from *Be Green* Measures | 9 | 28% |
| **Cumulative On-Site Savings** | **15** | 47% |

**Table 3: Site Wide Carbon Dioxide Emissions and Cumulative Savings**

| **Stage** | **Regulated Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum)** | **Regulated Carbon Dioxide Savings** | |
|---|---|---|---|
| | | **Tonnes $CO_2$ per Annum** | **Percentage** |
| Baseline: Part L 2013 Compliant Development | 2,180 | | |
| After ***Be Lean*** Measures | 1,886 | 294 | 14% |
| After ***Be Clean*** Measures | 865 | 1,021 | 47% |
| After ***Be Green*** Measures | 810 | 55 | 3% |
| | | | |
| **Cumulative On-Site Savings** | | **1,371** | 63% |

**Table 4 Shortfall in Regulated Carbon dioxide emission savings ($TCO_2$)**

| | | Annual | Over 30 years |
|---|---|---|---|
| Detailed | Domestic shortfall to Zero Carbon | 166 | 4,988 |
| | Non-Domestic shortfall to 35% improvement | 0 | 0 |
| | **Cash in lieu payment (£60/TCO2)** | | £299,271 |
| Outline | Domestic shortfall to Zero Carbon | 626 | 18,785 |
| | Non-Domestic shortfall to 35% improvement | 0 | 0 |
| | **Cash in lieu payment (£60/TCO2)** | | £1,127,085 |
| Entire | Domestic shortfall to Zero Carbon | 792 | 23,773 |
| | Non-Domestic shortfall to 35% improvement | 0 | 0 |
| | **Cash in lieu payment (£60/TCO2)** | | £1,426,356 |

# Contents

# 1. INTRODUCTION

**1.1** This Energy Statement has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, appointed by Cambridge Road (RBK) LLP. This statement is in support of the planning application for the proposed development at Cambridge Road Estate, in the Royal Borough of Kingston Upon Thames.

**1.2** The aim of this energy statement is to demonstrate that the energy strategy developed at planning for this development meets the requirements of the London Plan.

**1.3** The hybrid application consists of:

> Outline Planning Permission, with all matters reserved apart from access, layout and scale for demolition of existing buildings and erection of 2,170 residential units (Use Class C3), 1,775 $m^2$ community floorspace (Use Class F2), 698 $m^2$ of flexible office (Use Class E), 1,093 $m^2$ of flexible retail/commercial floorspace (Use Class E/F2), new publicly accessible open space and associated access, servicing, parking, landscaping and works; and

> Detailed Planning Permission for erection of 450 residential units (Use Class C3), 1,775 $m^2$ community floorspace (Use Class F2), 318 $m^2$ of flexible office (Use Class E), 204 $m^2$ of flexible retail/commercial floorspace (Use Class E/F2), new publicly accessible open space and associated access, servicing, parking, landscaping and works ("the Proposed Development").

**1.4** The formulation of the energy statement is on the basis that it targets a viable reduction in carbon dioxide ($CO_2$) emissions through the application of the London Plan Energy Hierarchy with an affordable, deliverable, and technically appropriate strategy.

**1.5** This statement establishes a baseline assessment of the energy demands and associated $CO_2$ emissions for Cambridge Road Estate. It reflects the Approved Document Part L 1A (2013) and Part L 2A (2013) baseline for new build dwellings and non-domestic construction, respectively.

**1.6** The report will then follow The London Plan Energy Hierarchy approach to enable the maximum viable reductions in Regulated and Total $CO_2$ emissions as follows:

> **Be Lean** – minimum 10% reduction over Part L 2013 for residential areas, and 15% reduction from non-residential areas from energy efficiency measures alone;

> **Be Clean** – use a decentralised heat network to supply heating and hot water;

> **Be Green** – consideration of the feasibility of on-site renewable technology;

> A minimum on-site 35% reduction over Part L 2013, with any residual residential Regulated $CO_2$ emissions offset through a carbon offset payment to the local borough, to achieve the standard of **Zero Carbon**.

# 2. DEVELOPMENT OVERVIEW

**2.1** The proposed development of Cambridge Road Estate is to take place within the Royal Borough of Kingston Upon Thames, as shown in

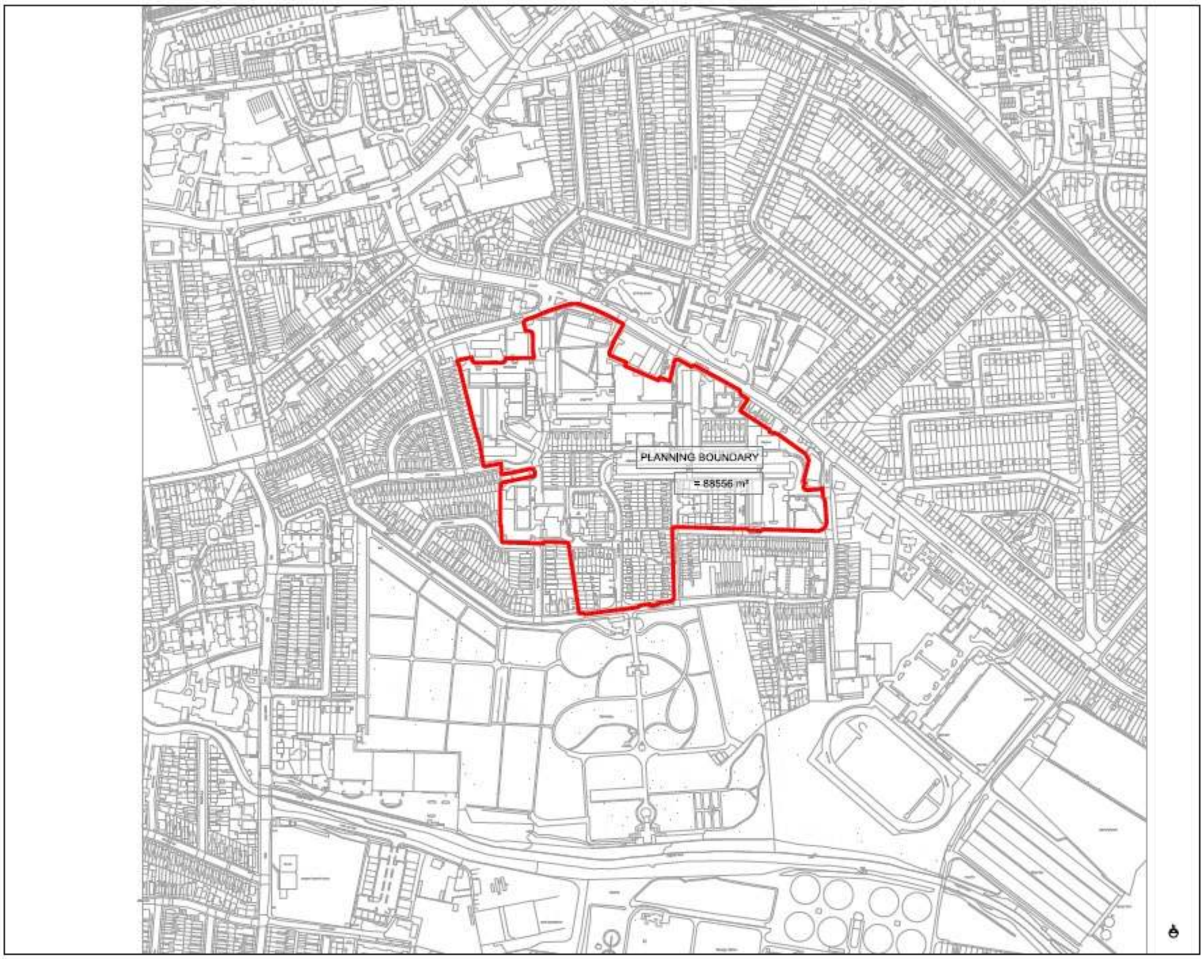


**Figure 1: Site plan Courtesy of Patel Taylor**

## Development description

**2.2** The application consists of:

> Hybrid Outline Planning Application for a mixed use development, including demolition of existing buildings and erection of up to 2,170 residential units (Use Class C3), 290 m² of flexible office floorspace (Use Class E), 1,395 m² of flexible retail/commercial floorspace (Use Class E/Sui Generis), 1,250 m² community floorspace (Use Class F2), new publicly accessible open space and associated access, servicing, landscaping and works.

- Detailed permission is sought for access, layout, scale, appearance and landscaping of Phase 1 for erection of 452 residential units (Use Class C3), 1,250 $m^2$ community floorspace (Use Class F2), 290 $m^2$ of flexible office floorspace (Use Class E), 395 $m^2$ of flexible retail/commercial floorspace (Use Class E/Sui Generis), new publicly accessible open space and associated access, servicing, parking, landscaping works including tree removal, refuse/recycling and bicycle storage, energy centre and works ("the Proposed Development").

**2.3** Figure 2 provides the proposed development site plan.

**2.4** It should be noted that the non-domestic components will be designed to be shell and core only. This includes the community centre, of which the current designs can only be demonstrated to a shell specification. This is in the absence of an agreement with the community as to the required specification.

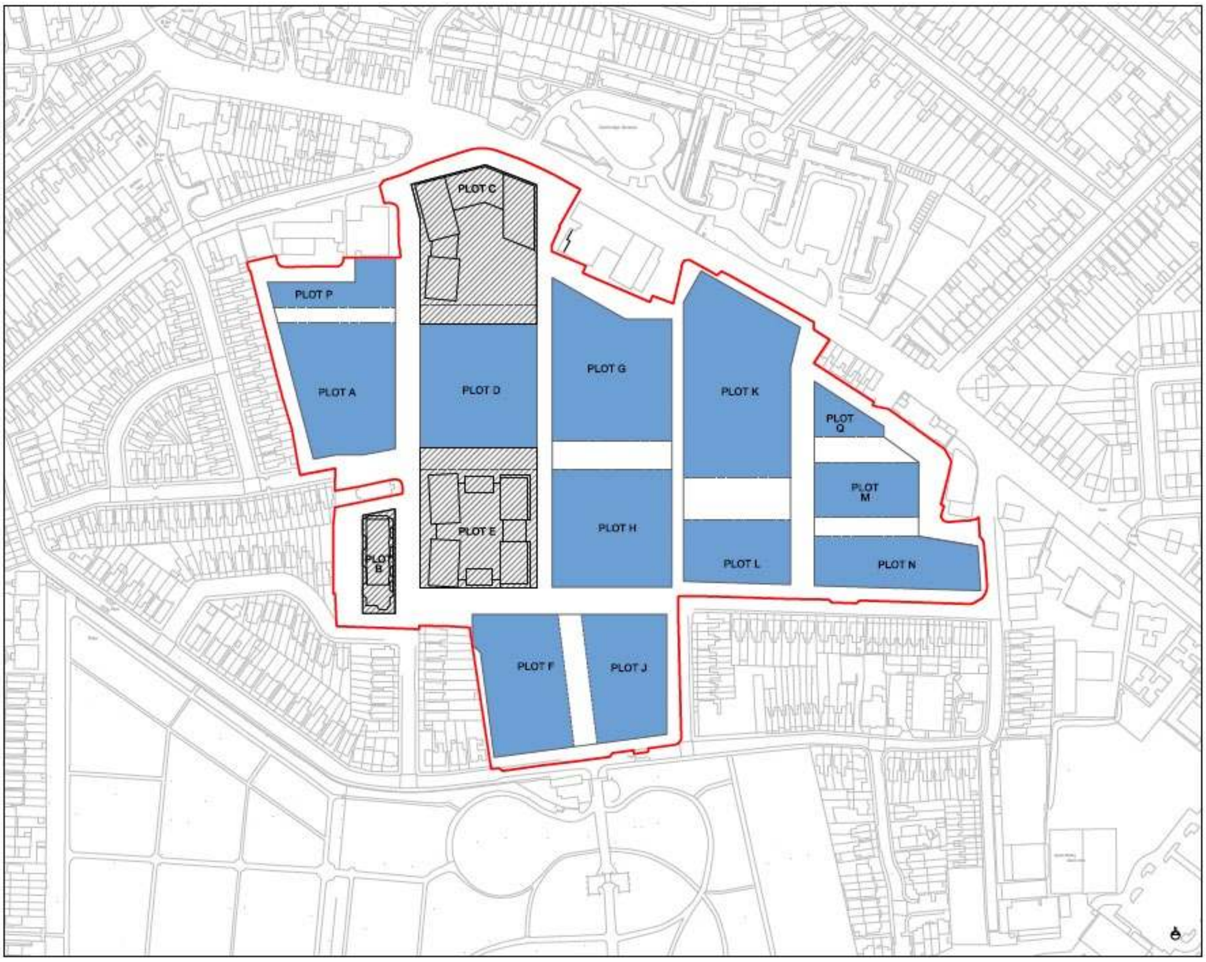


Figure 2: Proposed Masterplan Layout – Patel Taylor (October 2020)

# 3. RELEVANT PLANNING POLICY

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

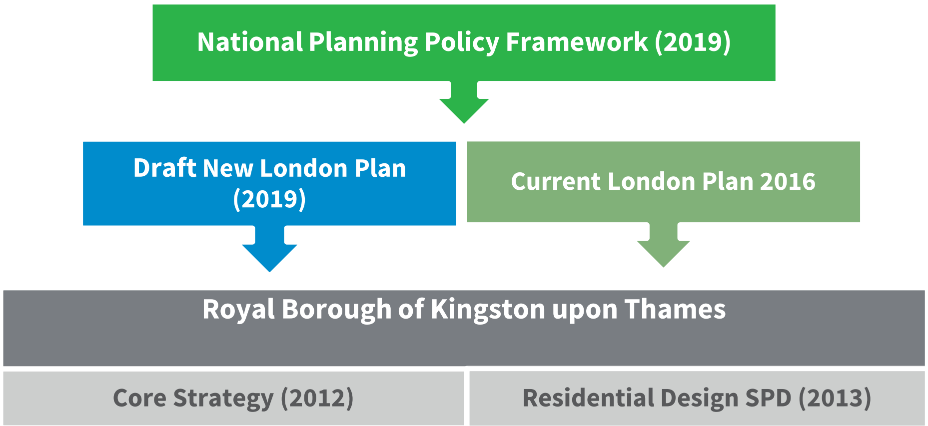


**Figure 3: Relevant Planning Policy Documents**

## National Policy: NPPF

**3.2** The revised National Planning Policy Framework (NPPF) was published on the 19th February 2019 and sets out the Government’s planning policies for England.

**3.3** The NPPF provides a framework for achieving sustainable development, which has been summarised as “*meeting the needs of the present without compromising the ability of future generations to meet their own needs*" (Resolution 42/187 of the United National General Assembly). At the heart of the framework is a **presumption in favour of sustainable development**.

**3.4** The document states that the planning system has three overarching objectives which are interdependent and need to be pursued in mutually supportive ways:

a) **An economic objective** – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;

b) **A social objective** – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and

c) **An environmental objective** – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

## Regional Policy: The London Plan

## Intend to Publish London Plan (2019)

**3.5** The Panel of Inspectors report into the draft London Plan was published in October 2019. The Mayor considered the Inspectors' recommendations and, in December 2019, issued to the Secretary of State the Intend to Publish London Plan. The Secretary of State responded to this in March 2020 and the Mayor is now considering the Secretary of State's response and taking the steps to finalise the plan.

**3.6** The following policies in the Intend to Publish London Plan are considered relevant to the proposed development and this Statement:

**3.7** **Policy SI2 Minimising Greenhouse Gas Emissions** states that major development should be net zero-carbon. This is to be demonstrated through the application of the energy hierarchy demonstrated in Figure 4, which has an added step from those in previous versions of the London Plan. Though, at this stage still to be consulted upon, "*Be Seen*" intends to monitor, verify, and report on carbon emissions.

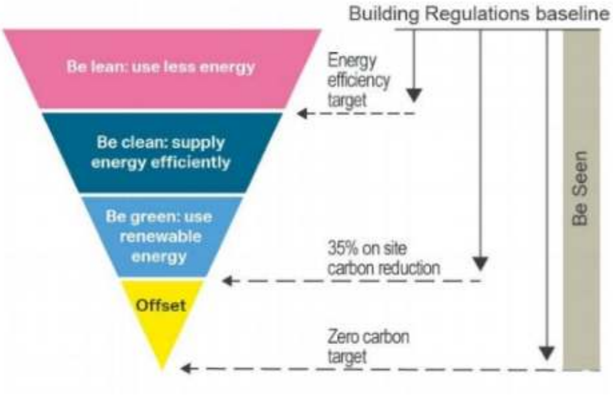


**Figure 3: New London Plan Energy Hierarchy (GLA)**

**3.8** The requirement for major developments is to:

> Achieve a 10% and 15% reduction in carbon emissions for residential and non-residential developments, respectively, through energy efficiency measures alone against a Part L baseline;

> Maximise onsite renewable energy.

> Achieve a minimum onsite reduction in carbon emissions of 35% beyond the Part L baseline.

> Offset shortfalls between the onsite improvements and zero carbon emissions.

3.9 Where there is a requirement to offset onsite carbon emissions, it can be completed in two ways:

> Through a cash in lieu contribution to the borough's carbon offset fund;

> Or alternatively, off-site provided it is identifiable as a deliverable alternative.

3.10 This policy further discusses considering carbon emissions from other elements of the development and thereby conducting a life-cycle carbon assessment.

3.11 **Policy SI3 Energy Infrastructure** states that energy masterplans should be developed for large-scale development locations which establish the most effective energy supply options. The policy further discusses that energy masterplans should consider options to produce the most effective energy supply option. Developments within a Heat Network Priority Areas should have communal low-temperature heating systems, with heat sources from communal systems following a heating hierarchy as follows:

> Connect to local existing or planned heat network;

> Use zero-emission or local secondary heat sources in conjunction with heat pumps if required;

> Use Low Emission CHP;

> Use ultra-low NOx gas boilers

3.12 Such heat networks are expected to be designed in line with CIBSE / ADE Code of Practice CP1 or equivalent.

3.13 **Policy SI4 Managing Heat Risk** states that major development proposals should demonstrate through an energy strategy how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the cooling hierarchy.

## The Current London Plan (2016)

3.14 The following outlines key policies set out in the current London Plan which are relevant to the proposed development and this Energy Statement.

3.15 **Policy 5.2 – Minimising Carbon Dioxide Emissions** requires that all residential and non-residential major developments achieve a specific improvement. The London Plan Sustainable Design and Construction SPG (2014) updates this target stating that the Mayor will adopt an onsite carbon dioxide improvement target beyond Part L 2013 of 35%. The Policy also states that all residential buildings built after 2016 must be zero carbon.

3.16 For residential developments, where zero carbon cannot be demonstrated on-site, any shortfall may be provided offsite or through a cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere. The calculation would be based on a cash-in-lieu contribution of £60/$TCO_2$.

3.17 **Policy 5.3 – Sustainable Design and Construction** states that the highest standards of sustainable design and construction should be achieved in London to improve the environmental performance of new developments. Major development should meet the minimum standards outlined in the London Plan Supplementary Planning Guidance and this should be clearly demonstrated.

3.18 **Policy 5.5 – Decentralised Energy Networks** states that the Mayor expects 25 per cent of the heat and power used in London to be generated using localised decentralised energy systems by 2025. The Mayor will prioritise the development of decentralised heating and cooling networks at the development and area wide levels, including larger scale heat transmission networks.

3.19 **Policy 5.6 – Decentralised Energy** requires that all developments should evaluate the feasibility of Combined Heat and Power (CHP) systems and examine the opportunities to extend the system beyond the site boundary to adjacent sites.

3.20 **Policy 5.7 – Renewable Energy** states that within the framework of the Energy Hierarchy, major development proposals should provide a reduction in expected carbon dioxide emissions using on-site renewable energy generation, where feasible. No specific target is provided in the policy.

3.21 **Policy 5.8 – Innovative Energy Technologies** encourages the more widespread use of innovative energy technologies to reduce use of fossil fuels and carbon dioxide emissions.

3.22 **Policy 5.9 – Overheating and cooling** encourages the design of places and spaces to avoid overheating and excessive heat generation, and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis.

## Sustainable Design and Construction Supplementary Planning Guidance (2014)

3.23 The London Plan Sustainable Design and Construction SPG was adopted in April 2014 and provides detail and best practice guidance on how to implement the sustainable design and construction and wider environmental sustainability London Plan policies.

3.24 The SPG provides guidance on topics such as energy efficient design; meeting carbon dioxide reduction targets; decentralised energy; how to off-set carbon dioxide where the targets set out in the London Plan are not met; retro-fitting measures; monitoring energy use during occupation; air quality; resilience to flooding; urban greening; pollution control; basements and local food growing.

## Energy Assessment Guidance (October 2020)

**3.25** The Greater London Authority (GLA) have published their Energy Assessment Guidance. It provides advice on how the energy statement can demonstrate compliance with the London Plan Policy 5.2. The following are key points taken from the document:

> It provides guidance on the approach on how to complete the assessment for various planning application types. For instance, Reserved Matters applications should conform to the requirements set out in the Outline Planning Consent;

> The GLA encourage the use of SAP 10.0 carbon factors for referable schemes;

> The GLA signal future policy changes in the draft London Plan. It highlights the policy, which is not in place now, will require carbon emissions improvement because of energy efficiency, Be Lean, of 10% and 15% for domestic and non-domestic developments respectively;

> There are requirements to report energy demands and improvements in carbon emissions;

> Areas not considered as shells are required to complete cooling and overheating assessments under Be Lean;

> Greater detail on selecting energy systems with requirements to provide data for assessing air quality and limiting the impacts of combustion plant in terms of $NO_X$ and $PM_{10}$.

**3.26** This application will aim to achieve the GLA $CO_2$ targets by utilising the SAP 10.0 carbon emission factors.

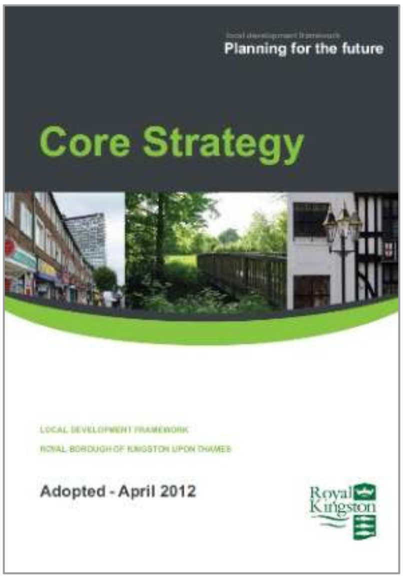
## Local Policy: Royal Borough of Kingston Upon Thames

**3.27** The Royal Borough of Kingston Upon Thames' Core Strategy document was adopted in April 2012. The following policies are considered relevant to this Statement:

**3.28** **Policy CS1 – Climate Change Mitigation**: All development must be designed and built to make the most efficient use of resources, reduce its lifecycle impact on the environment and contribute to climate change mitigation and adaptation by:

> Reducing $CO_2$ emissions during construction and throughout the lifetime of the development;

> Building to the highest sustainable design and construction standards;



Planning for the future

Core Strategy

LOCAL DEVELOPMENT FRAMEWORK

ROYAL BOROUGH OF KINGSTON UPON THAMES

Adopted - April 2012

Royal Kingston

3.29 **Policy CS2 – Climate Change Adaptation**: The Council will ensure that future development takes into consideration the following:

> Hotter summers and therefore increased cooling demands;

> Warmer, wetter winters and increased flood risk;

> Water shortages and drought;

> Urban heat island effect.

3.30 **Policy DM1 – Sustainable Design and Construction Standards**: The Council will require all new residential developments to achieve successively higher levels of the Code for Sustainable Homes Level category for energy/$CO_2$.

New development should minimise air, noise, and contaminated land impacts in line with industry best practice. Development proposals for contaminated land should include remediation measures.

The Council will promote good carbon management by monitoring $CO_2$ emissions to ensure the development is operated within the $CO_2$ emissions standards of the as-built specification and those outlined within the Council’s Sustainable Design and Construction SPD. Measures to ensure these standards are maintained will be monitored by the Council.

Where appropriate, other new build developments over 500 $m^2$ are encouraged to achieve higher levels of the appropriate BREEAM standard.

3.31 For reference to the policy text above, since the publication of the Royal Borough of Kingston Upon Thames’ Core Strategy Document in April 2012, the Code for Sustainable Homes was formally wound down following a technical housing standard review. This was announced by the Ministerial Statement by Rt. Honourable Eric Pickles on 25th March 2015 and the Government withdrew the Code for Sustainable Homes on 22nd April 2015.

3.32 **Policy DM2 – Low Carbon Development**: The development of energy generating infrastructure will be fully encouraged by the Council providing that any opportunities for generating heat simultaneously with power are fully exploited.

## Residential Design Supplementary Planning Document (SPD)

3.33 The Royal Borough of Kingston Upon Thames’ Residential Design SPD document was adopted in July 2013. The following policies are considered relevant to this Statement:

**3.34** **Policy Guidance 3 – Sustainable Design**: Developers are encouraged to exceed statutory requirements as set out in London Plan policy 5.3, the Mayor's Housing SPG, and in Core Strategy Policies DM1 and DM3 with particular attention given to:

> Minimising energy and $CO_2$ emissions;

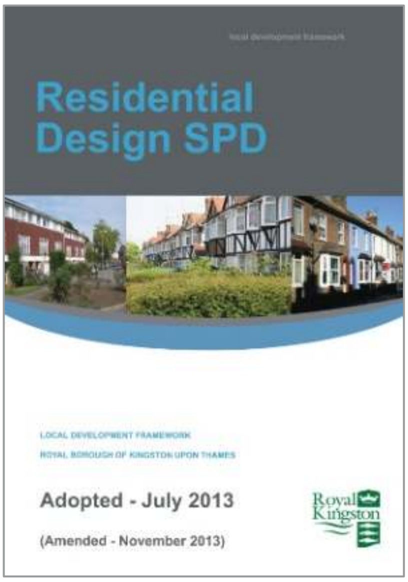
> Efficient use of natural resources (including water);

> Design of streets and siting of buildings;

> Optimising building density;

> Incorporation of green/blue infrastructure.

**3.35** Since the publication of the Royal Borough of Kingston Upon Thames' Residential Design SPD in July 2013, the Code for Sustainable Homes was formally wound down following a technical housing standard review. This was announced by the Ministerial Statement by Rt. Honourable Eric Pickles on 25th March 2015 and the Government withdrew the Code for Sustainable Homes on 22nd April 2015.



Residential Design SPD

LOCAL DEVELOPMENT FRAMEWORK

ROYAL BOROUGH OF KINGSTON UPON THAMES

Adopted - July 2013

(Amended - November 2013)

Royal Kingston

## Summary of Policy Targets

**3.36** Achieve 35% Regulated $CO_2$ reduction over Part L 2013 onsite**.**

**3.37** Implement the **Energy Hierarchy**: *Be Lean* (energy efficiency); *Be Clean* (heating infrastructure); and *Be Green* (renewable energy technologies).

**3.38** Use SAP 10.0 carbon factors to determine carbon and energy savings, while ensuring compliance with Part L 2013.

**3.39** The **GLA Zero Carbon Homes** policy will apply to the residential units only.

**3.40** The cash-in-lieu sum based on RBKUT's £60 current cost per ton

# 4. BASELINE EMISSIONS ASSESSMENT

## Methodology

**4.1** The GLA's Energy Assessment Guidance document suggests using SAP 10.0 carbon emission factors to estimate $CO_2$ performance of the proposed development. This application will follow this approach.

## Residential

**4.2** The estimated energy demand for the residential portion of the development has been calculated using Standard Assessment Procedure (SAP 2012) methodology. SAP calculated the Regulated energy demand for residential dwellings.

**4.3** SAP calculations have been carried out for representative dwelling types in Phase 1 (the detailed component). These encompass ground, mid, and top floor flats and represent a fair aggregation of the expected unit mix of the development.

**4.4** To calculate the energy demands across the entire scheme, the illustrative accommodation schedule has been used to extrapolate the results from the modelled units. This has been done for both the detailed and outline parts of the application.

**4.5** The Unregulated energy demands for the residential units have been calculated using the methodology outlined in the SAP 2012 document (version 9.92 – October 2013). This calculates the $CO_2$ emissions associated with appliances and cooking.

## Non-Residential

**4.6** The estimated energy demand for the non-residential elements of the development has been calculated using Simplified Building Energy Model (SBEM) software, using the National Calculation Method (NCM 2013 Edition). SBEM calculates the Regulated energy demands associated with hot water, space heating and fixed electrical items, as well as Unregulated energy demands.

**4.7** Sample SBEM calculations have been carried out on example units of the expected use types for the proposed development. For the outline scheme, these are not fixed, but sample calculations have been extrapolated to gain energy demand estimates for the whole scheme.

**4.8** As discussed earlier the non-residential elements of the development are shells and as such suitable assumptions have been applied for the purposes of this statement.

## Baseline Carbon Emissions

**4.9** Table 5, below, shows the baseline Regulated and Unregulated $CO_2$ emissions for the development. A summary of these calculations is shown in Appendix A. TER and BRUKL Worksheets supporting these calculations are shown in Appendices B and D, respectively.

**Table 5: Carbon Dioxide Emissions Baseline for Residential and Non-Residential Areas**

| Application Component | Usage | SAP 10.0 Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum) | | |
|---|---|---|---|---|
| | | Residential | Non-Residential | Cumulative |
| Detailed | Regulated | 450 | 16 | 466 |
| | Unregulated | 257 | 5 | 262 |
| Outline | Regulated | 1,698 | 16 | 1,714 |
| | Unregulated | 968 | 2 | 970 |
| Entire Scheme | Regulated | 2,148 | 33 | 2,180 |
| | Unregulated | 1,225 | 7 | 1,232 |

# 5. BE LEAN: DEMAND REDUCTION

**5.1** The first stage of the London Plan Energy Hierarchy is demand reduction from energy efficiency measures. Passive design measures as well as active energy efficient design measures will go above and beyond Part L 2013 $CO_2$ emission requirements, and aim for the new London Plan target of a 10% $CO_2$ reduction for residential areas, and 15% $CO_2$ reduction in non-residential areas at the ***Be Lean*** stage of the Energy Hierarchy.

**5.2** The fabric energy efficiency strategy should be reviewed at each detailed stage of the development, to ensure that the most recent policy targets are being achieved.

## Residential

### Building Fabric

**5.3** The following fabric energy efficiency targets have been assumed to estimate the energy performance for the proposed development. This is an example of an energy strategy that will achieve the Intend to Publish London Plan requirements:

> External wall U-values of 0.17 W/m$^2$K (based on a wall thickness of approximately 450 mm);

> Corridor wall U-values of 0.20 W/m$^2$K;

> Party walls to be fully filled and sealed to achieve a U-value of 0.00 W/m$^2$K;

> Flat roof U-values of 0.13 W/m$^2$K;

> Exposed floor U-values of 0.10 W/m$^2$K;

> High performance double glazing with U-values of 1.30 W/m$^2$K, a g-values depending on façade.

### Air Tightness and Ventilation

**5.4** Dwellings are likely to be fitted with an efficient **Mechanical Ventilation with Heat Recovery (MVHR)** system. This provides a whole dwelling ventilation system that supplies and extracts air, reusing heat that would have been lost as illustrated in Figure 6. The dwelling MVHR unit is suggested to target a specific fan power (SFP) of 0.53 -0.88 W/l/s and a heat recovery efficiency at least 84%.

5.5 At this stage, a target design air permeability of 3 $m^3/hr.m^2$ has been assumed as appropriate.

5.6 Additionally, where possible, dwellings will have openable windows and be able to naturally ventilate if required. This will facilitate convective ventilation and night purging of heat.

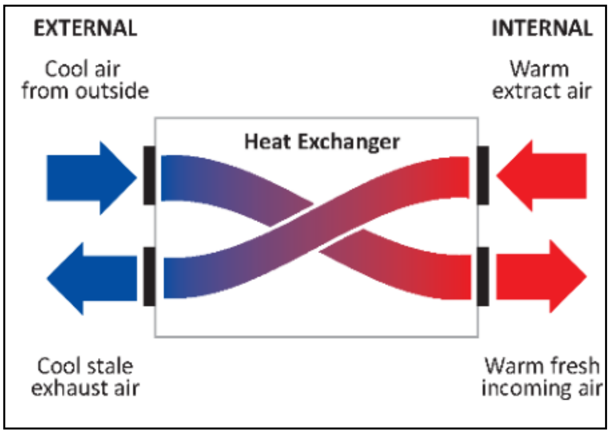


Figure 4: Mechanical Ventilation with Heat Recovery

## Thermal Bridging

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

5.8 Part L1A places increased importance on addressing heat losses through thermal bridging. As such, the Applicant is committed to develop a building fabric where these are minimised as far as practical. Bespoke calculations to improve on default psi values should be targeted.

5.9 At this stage of the design it is intended that the proposed structure will be a concrete frame. Based on this and prior experience indicative psi values that may be required for each junction are presented in Table 6. This should be reviewed at each detailed stage of the development.

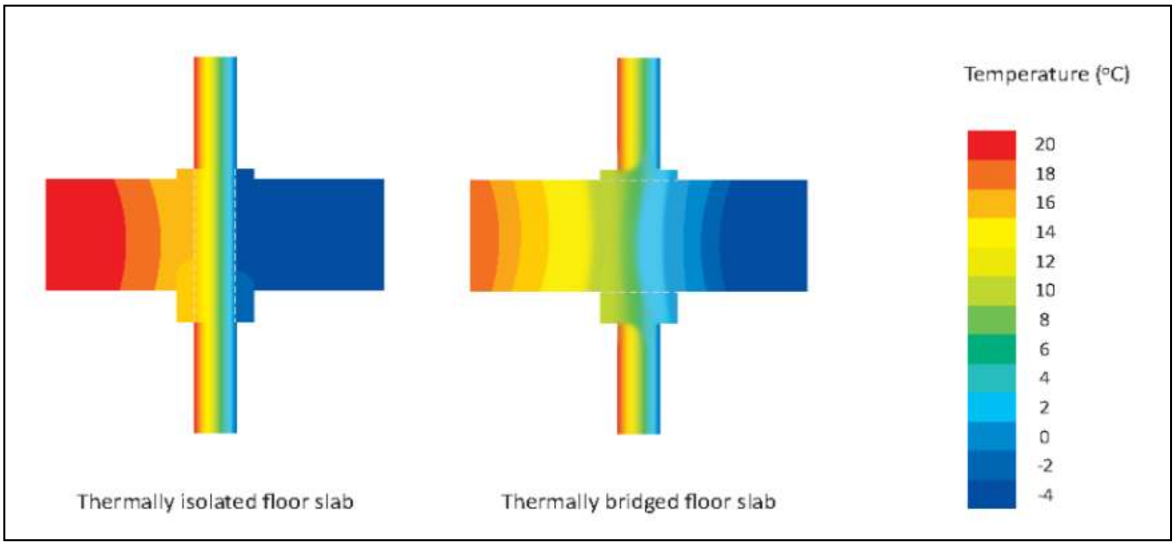


Figure 5: Thermal Bridges

**Table 6: Indicative Thermal Bridging Psi Value Targets**

| SAP Ref. | Junction | Default value | Target value |
|---|---|---|---|
| E1 | Lintels | 1.00 | 0.10 |
| E3 | Sill | 0.08 | 0.04 |
| E4 | Jamb | 0.10 | 0.05 |
| E20 | Exposed floor to external wall | 0.32 | 0.15 |
| E7 | Intermediate Floor | 0.14 | 0.20 |
| E23 | Balconies | 1.00 | 0.25 |
| E15 | Flat roof with parapet | 0.56 | 0.35 |
| E16 | External corner | 0.18 | 0.05 |
| E17 | Inverted corner | 0.00 | -0.05 |
| E18 | Party corner | 0.12 | 0.03 |
| P7 | Party exposed floor | 0.16 | 0.05 |
| P4 | Party roof | 0.24 | 0.03 |

## Space Heating and Hot Water

**5.10** At the *Be Lean* stage, it is assumed that the heating and hot water is supplied by a communal gas boiler network, with an efficiency of 89.5%. All homes are expected to be connected to the heat network with Heat Interface Units (HIU).

## Unregulated Energy Demands

**5.11** Unregulated energy demands include energy needed for cooking and powering appliances within the home. The energy associated with these uses are dependent on the occupant of the home and can vary substantially. However, the Applicant is committed to ensuring that all efforts are made to enable the residents to minimise their unregulated energy consumption.

## Mitigation Against Summer Overheating

**5.12** A Summer Overheating Mitigation report has been prepared for the proposed development and is presented in Appendix E. Through the application of the cooling hierarchy overheating can be mitigated by the application of the proposed optimised fabric, shading devices such as balconies and an appropriate ventilation strategy maximising natural ventilation with minimum ventilation rates guaranteed through mechanical means.

# Non-Residential

**5.13** The following specification is based on the non-domestic units being considered as shells in line with discussion in Chapter 2. This means that the specifications noted below can only be assumptions.

## Building Fabric

**5.14** An example fabric energy efficiency strategy for the non-residential units is as follows:

> External wall U-value of 0.17 W/m$^2$K;

> Ground floor U-value of 0.12 W/m$^2$K;

> Exposed floor U-value of 0.14 W/m$^2$K;

> Roof U-value of 0.12 W/m$^2$K;

> Glazing U-value of 1.20 W/m$^2$K, with a g-value of 0.30 and light transmittance of 0.60.

## Ait tightness & Ventilation

**5.15** The targeted air permeability rate at this stage is 5 m$^3$/m$^2$.hr.

**5.16** It is expected that ventilation will be provided mechanically. The units are likely to have a specific fan power of around 1.40 W/l/s and likely to benefit, from heat recovery of around 89% with a summer bypass.

## Lighting

**5.17** The non-residential units are proposed to have high efficiency LED lighting with a luminance of 100 lm/W. It is assumed photoelectric lighting with dimming will be in perimeter zones and occupation sensor auto on/off control will be utilised.

## Metering and Controls

**5.18** Sub-metering of the non-domestic units is to be applied in line with the requirements of Part L.

## Heating and Hot Water

**5.19** At the ***Be Lean*** stage, it is assumed that heating and hot water is supplied by a communal gas boiler, with an efficiency of 91%.

## Cooling

**5.20** The commercial units are small shells therefore the design team has sought to minimise cooling requirements through the application of the cooling hierarchy. As a result of careful fabric and window selection and efficient lighting the heat gains have been minimised. This in turn ensures that cooling will be minimise as shown in Table 7.

**5.21** It is assumed that the cooling demands of the non-residential units are met by an Air Source Heat Pump. The assumed efficiency of this system is a SEER of 6.5 and an EER of 4.2.

**Table 7: Cooling Demands for Non-Residential Areas**

| Scheme Component | Area weighted average non-residential cooling demand (MJ/m$^2$) |
|---|---|
| Actual | 38.1 |
| Notional | 48.7 |

# $CO_2$ Emissions Following *Be Lean* Measures

**5.22** Table 8, below, shows the site wide estimated Regulated $CO_2$ emissions following the ***Be Lean*** measures outlined above. As shown, these measures result in a $CO_2$ emissions reduction of 13% over Part L 2013 baseline for residential development, and 20% for non-residential development, which complies with Intend to Publish London Plan policy.

**5.23** A summary of these calculations is shown in Appendix A. DER worksheets and BRUKL to support these calculations are shown in Appendices C and D, respectively.

*Table 8: Regulated Carbon Dioxide Emissions at Be Lean Stage*

| | **Stage** | *SAP 10.0 Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum)* | | |
|---|---|---|---|---|
| | | **Residential** | **Non-Residential** | ***Cumulative*** |
| Detailed | Baseline | 450 | 16 | 466 |
| | After *Be Lean* Measures | 390 | 13 | 403 |
| | **Total Emissions Reduction** | 60 | 3 | 63 |
| | **Percentage Reduction after *Be Lean*** | 13% | 20% | 14% |
| Outline | Baseline | 1,698 | 16 | 1,714 |
| | After *Be Lean* Measures | 1,470 | 13 | 1,483 |
| | **Total Emissions Reduction** | 228 | 3 | 231 |
| | **Percentage Reduction after *Be Lean*** | 13% | 0% | 13% |
| Entire | Baseline | 2,148 | 33 | 2,180 |
| | After *Be Lean* Measures | 1,860 | 26 | 1,886 |
| | **Total Emissions Reduction** | **288** | **6** | **294** |
| | **Percentage Reduction after *Be Lean*** | **13%** | **20%** | **14%** |

**5.24** Table 9, below, shows the total energy demand (MWh/year) for each building use of the proposed development. This is the delivered energy requirement at point of use and is assuming both the detailed and outline parts of the scheme are included.

**Table 9: Energy demand following energy efficiency measures (MWh/year)**

| **Building Use** | **Space Heating** | **Hot Water** | **Lighting** | **Auxiliary** | **Cooling** | **Unregulated electricity** |
|---|---|---|---|---|---|---|
| Residential Total | 3,568 | 4,168 | 640 | 369 | 0 | 5,257 |
| Non-residential Total | 33 | 1 | 23 | 7 | 7 | 30 |

**5.25** Table 10 and Appendix A demonstrates the fabric energy efficiency attained by the proposed design.

**Table 10: Fabric Energy Efficiency**

| | Target Fabric Energy Efficiency (kWh/m$^2$/year) | Design Fabric Energy Efficiency (kWh/m$^2$/year) | Improvement (%) |
|---|---|---|---|
| Development Total | 47.16 | 41.16 | 13 |

## Whole Life Cycle Assessment

**5.26** A Whole Life Cycle Carbon Assessment has been undertaken to give early consideration of how to minimise embodied carbon in the construction of the development. The report can be found in Appendix F.

# 6. BE CLEAN: HEATING INFRASTRUCTURE

**6.1** In line with the current London Plan Policy 5.6 and the Intend to Publish London Plan Policy SI3 (Energy Infrastructure), the heating and hot water provision has been considered in line with the following heating hierarchy from SI 3:

> Connect to local existing or planned heat networks;

> Use zero-emission or local secondary heat sources (in conjunction with heat pump, if required);

> Use low-emission combined heat and power (CHP);

> Use ultra-low NOx boilers.

## Connect to local existing or planned heat networks

**6.2** The proposed development is within proximity of a planned heat network. Following the hierarchy mentioned above, this opportunity was considered in detail.

**6.3** The planned Royal Borough of Kingston Upon Thames (RBKUT) district wide network (DEN) is in the advanced stages of its design having completed initial feasibility and having received additional grant funding to complete wider detailed technical studies.

**6.4** The applicant’s design team have engaged with the RBKUT DEN for the purposes of promoting an enabling environment for the connection to the network.

### RBKUT DEN

**6.5** The RBKUT DEN is designed to utilise heat from a local water facility on the Hogsmill river. Currently the wastewater from this facility is leading to higher water temperatures in the local environment. This excess heat can be used to provide renewable heat with the use of water source heat pumps. The heat source is south of the development beyond the cemetery.

**6.6** Following consultation with the RBKUT DEN, they have confirmed that the Cambridge Road Estate is likely to be its anchor node. They further confirmed various parameter associated with the DEN, as described in Table 11.

**Table 11: RBKUT DEN parameter**

| Parameter | RBKUT DEN | On development |
|---|---|---|
| Technology | Water Source Heat Pump | Gas fired boilers |
| Technology heating efficiency | 350% | 89% |
| Proportion of heat generated for development | 99% | 1% |
| Fuel use | Electricity | Natural gas |
| Air quality impacts | n/a | 8.8 MWh heating |
| SAP 10.0 Carbon factor | 0.233 kg $CO_2$/kWh | 0.210 kg $CO_2$/kWh |
| Thermal stores | No | |
| Heat loss | Based on Industry standards (CIBSE CP1: Heat Networks code of practice for the UK) – 25% heat loss | |
| Heat cost | Competitive with alternative strategy (see later) | |

**6.7** Discussions with the RBKUT DEN have suggested that 99% of the annual heat requirements for the development can be provided. A 100% guarantee is not available because the RBKUT have outlined that they will not be providing any back up heating plant and will therefore require downtime for the purposes of proactive maintenance. As a result, full peak capacity plant would be required on site.

**6.8** To produce the remaining heat, a central Energy Centre at the base of Block E is proposed, see Figure 6 and Appendix G. The following spatial parameters have been provided following consultation with the building services engineers appointed at this stage of the works. It is expected that the dimensions will be sufficient for the proposed heat strategy.

> Area: 449 m$^2$

> Average height: 3.75 m

> Maximum height: 5.15 m

**6.9** Through discussions with RBKUT, it is expected that the RBKUT DEN heat costs would be competitive with an onsite alternative. As an early estimate that will be developed further, variable heat costs could be around 6 p/kWh. It should be noted that the financial model that will be utilised for the RBKUT DEN is still to be fully developed. As this develops, greater clarity will be realised in terms of the associated heat costs. It would be expected that the fixed charges would be in alignment with the discussions provided by the Heat Trust.

**6.10** Figure 7 and Appendix H shows the district heat network for the development, which will distribute heat from the energy centre in Block E to the rest of the development. It is expected that the heat loss associated with the heat network will be calculated in line with CIBSE CP1: Heat Networks code of practice for the UK. At this stage of the design, the heat loss has been demonstrated to be less than 25% of delivered heat.

**6.11** As consulted, and agreed, with the GLA and RBKUT this energy centre will house gas boilers capable of delivering the required heat for the entire development. This energy centre will also act as the central location for connecting to the RBKUT DEN with the use of a plate heat exchangers.

**6.12** It is estimated that 6.8 MW of gas boilers capacity will be required to produce the required heat for the development. Figure 8 and Appendix H provides an indicative plant room layout for the strategy described. The heat generated will be predominantly for the dwellings and potentially for the commercial units. The commercial units are small and are shells. As such they could be offered an opportunity to connect but for the purposes of this energy statement are not considered to connect to the heat network.

Figure 6: Block E energy centre plan and section courtesy of Patel Taylor

**Figure 7: Cambridge Road Estate Heat Network with DEN connection courtesy of AWA Building Services Consultants**

Figure 8: Indicative Block E energy centre layout courtesy of AWA Building Services Consultants

**6.13** The RBKUT DEN is not able to verify the timings for completing works and providing a connection. Therefore, to maximise the opportunity for connecting to the RBKUT DEN a mean time solution is proposed. The deadline for confirming connection to the RBKUT DEN would be expected to be up to a year before development completion.

**6.14** The mean time solution is currently expected to utilise the proposed gas boilers until a connection to the RBKUT DEN is presented or confirmed as not possible. To facilitate this connection a safe guarded route for the RBKUT DEN through the development is considered as described by Figure 9 and in greater detail within the parameter plans provided by Patel Taylor.

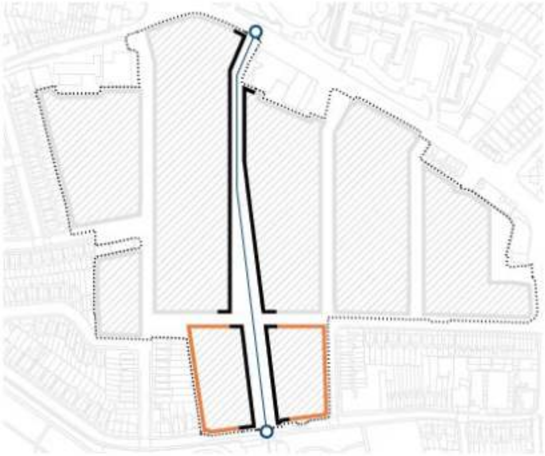


Figure 9: Safe guarded route for RBKUT DEN courtesy of Patel Taylor

## Alternative heating strategy

**6.15** If the RBKUT DEN connection is not possible, the alternative heating strategy is proposed as a heat pump led solution. This has been considered and expected to be a heat pump led solution. As discussed above, this alternative strategy would not be expected to be installed unless the RBKUT DEN were to be ruled out within the development's last year of completion.

**6.16** In line with the hierarchy discussed earlier, the proposed alternative strategy maximises the opportunity to connect to the planned wider heat network. At this stage, the preferential alternative heating strategy would be led by air source heat pumps and supported by gas boilers.

**6.17** An air source heat pump (ASHP) led heating strategy has an ability to be a plug and use technology without requirement for significant alteration to building design or hinderance to connecting to wider network. This technology provides flexibility for the last phases considered in the outline for use to hold the external plant required for the development. This plant could be located on the roof of future blocks and directed back to the central energy centre in Block E. Potential blocks for this are shown in Figure 10 and in Appendix I.

**6.18** Figure 10 and in Appendix I further demonstrates the safe guarded routes that would allow heat from the ASHP to be directed back to the Block E energy centre for providing heat to the development, should the alternative strategy be required.

**Figure 10: Indicative roof plant areas for the alternative strategy and safe guarded route back to energy centre courtesy of AWA Building Services Consultants**

**6.19** The following spatial parameters of the energy centre are expected to be sufficient for the proposed heat strategy and the alternative should the proposed strategy not be possible.

- Area: 449 $m^2$
- Average height: 3.75 m
- Maximum height: 5.15 m

**6.20** In addition to this, it is expected that the alternative energy strategy will require circa 260 $m^2$ of roof space for the ASHP plant.

**6.21** Figure 11 provides an indicative energy centre layout for the alternative energy strategy.

Figure 11: Indicative energy centre layout for the alternative strategy courtesy of AWA Building Services Consultants

**6.22** Table 12 provides an estimated of the plant requirements should the alternative heating strategy be required.

**Table 12: Alternative heating strategy parameter**

| Parameter | Heat technology 1 | Heat technology 2 |
|---|---|---|
| Technology | Air Source Heat Pump | Gas fired boilers |
| Capacity | 1.8 MW | 6.8 MW |
| Technology heating efficiency | 260% | 89% |
| Proportion of heat generated for development | 67% | 33% |
| Fuel use | Electricity | Natural gas |
| Air quality impacts | n/a | 291 MWh heating |
| SAP 10.0 Carbon factor | 0.233 kg $CO_2$/kWh | 0.210 kg $CO_2$/kWh |
| Thermal stores | Yes | |

**6.23** A development led heat pump heating strategy would require a greater proportion of heat from the gas boilers. This is a result of the technological constraints associated with air source heat pumps such as efficiency, and reliance on a variable heat source, air. As a result, it would only be expected to achieve the 35% on site requirements.

## $CO_2$ Emissions Following *Be Clean* Measures

**6.24** Table 13 shows the site wide Regulated $CO_2$ emissions of the development after the connection to the RBKUT DEN with on-site gas fired boilers as detailed above. A 60% reduction is now anticipated over the base case. Through measures at ***Be Clean***, the mandatory reduction of 35% through onsite measures has been accomplished

**6.25** A summary of these calculations can be found in Appendix J. Full DER worksheets for the ***Be Clean*** stage can be found in Appendices K.

**Table 13: Regulated Carbon Dioxide Emissions at *Be Clean* Stage**

| | **Stage** | *SAP 10.0 Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum)* | | |
|---|---|---|---|---|
| | | **Residential** | **Non-Residential** | ***Cumulative*** |
| Detailed | Baseline | 450 | 16 | 466 |
| | After ***Be Lean*** Measures | 390 | 13 | 403 |
| | After ***Be Clean*** Measures | 176 | 13 | 189 |
| | | | | |
| | **Total Emissions Reduction** | 274 | 3 | 277 |
| | **Percentage Reduction after *Be Clean*** | 61% | 20% | 59% |
| | | | | |
| Outline | Baseline | 1,698 | 16 | 1,714 |
| | After ***Be Lean*** Measures | 1,470 | 13 | 1,483 |
| | After ***Be Clean*** Measures | 663 | 13 | 676 |
| | | | | |
| | **Total Emissions Reduction** | 1,035 | 3 | 1,038 |
| | **Percentage Reduction after *Be Clean*** | 61% | 20% | 61% |
| | | | | |
| Entire | Baseline | 2,148 | 33 | 2,180 |
| | After ***Be Lean*** Measures | 1,860 | 26 | 1,886 |
| | After ***Be Clean*** Measures | 839 | 26 | 865 |
| | | | | |
| | **Total Emissions Reduction** | **1,309** | **6** | **1,315** |
| | **Percentage Reduction after *Be Clean*** | **61%** | **20%** | **60%** |

# 7. BE GREEN: RENEWABLE ENERGY

**7.1** The *Be Green* stage of the London Plan Energy Hierarchy seeks for renewable energy technologies to be specified to provide, where feasible, a reduction in expected $CO_2$ emissions.

**7.2** The development achieved the requirements of the London Plan because of the measures described in *Be Clean*. However, in line with good practice and Policy SI 2, the feasibility and maximisation of several renewable technologies have been considered and outlined below.

## Biomass

**7.3** Biomass boilers generate heat on a renewable basis as they are run on biomass fuel which is virtually carbon neutral.

**7.4** Biomass boilers are best suited to supply the base heating demand of the development. This would conflict with the proposed heat strategy of connecting to the wider heat network. Further Biomass boilers also require storage and regular fuel deliveries, which would likely be delivered by heavy good vehicles which will have a negative impact on local air quality.

**7.5** It has therefore been concluded that biomass is not the most suitable technology.

## Wind Turbines

**7.6** Urban rooftop wind turbines do not generally perform sufficiently to well to warrant their installation, due to the low and turbulent wind conditions present. They are therefore likely to remain technically unfeasible.

**7.7** It has therefore been concluded that wind turbines are not a suitable technology for this site.

## Heat Pumps

**7.8** Heat pumps reduce energy consumption and replace gas as the heating fuel with electricity. They can offer substantial reductions in $CO_2$ emissions. The only natural sources of heat by the development are ground and air.

**7.9** Ground Source Heat Pumps (GSHP) require extensive groundworks and have considerable upfront capital cost and design considerations. A GSHP is not appropriate for this application as it would preclude connection to the RBKUT DEN. It has therefore not been considered for this application to ensure priority is placed on connecting to the planned heat network.

**7.10** Air Source Heat Pumps (ASHP) can be a more economical alternative. This technology was discussed as a part of *Be Clean* as a part of the alternative energy strategy, with its potential impact demonstrated in Appendix Q.

**7.11** The technology is a practical and a well-recognised technology for commercial units. As explained in '*Be Clean*' the commercial units are small and as shells could be offered to connect to the heat network, however as described in the GLA Energy Assessment Guidance they would not be expected to do so. ASHPs are therefore proposed, as a part of this assessment, to provide the heating demand of the non-residential development in the event they do not connect. It is assumed that the heat pumps will have a SCOP of 4.50.

## Solar Photovoltaics (PV)

**7.12** PV panels generate electricity from solar radiation. The generating potential of PV panels is dependent on the availability of roof space and ensuring that they are not overshaded.

**7.13** There are several roof spaces which are flat and available for the installation of PV. The electricity generated from the PV is expected to be connected back to the landlord supply.

**7.14** Within Phase 1 (the detailed component), the upper roof levels of Blocks B, C, and E could be utilised for solar PV where they are not shaded. Indicative plans showing suggested locations for solar PV are shown in Figure 12 and Appendix L. Allowing for sufficient spacing between panels, maintenance access and amenity space, it is estimated that 55 kWp of solar PV could be provided within Phase 1. Based on the SAP 2012 methodology this is expected to generate circa 41 MWh of electricity annually.

**7.15** Based on the current outline a rudimentary estimate based on Phase 1 can be applied to determine the impact of PV across the entire development. Though a detailed assessment of the availability for solar PV for future phases should be considered at the time of each Reserved Matters Application, at this time an estimate of up to 210 kWp for the outline is potentially feasible.

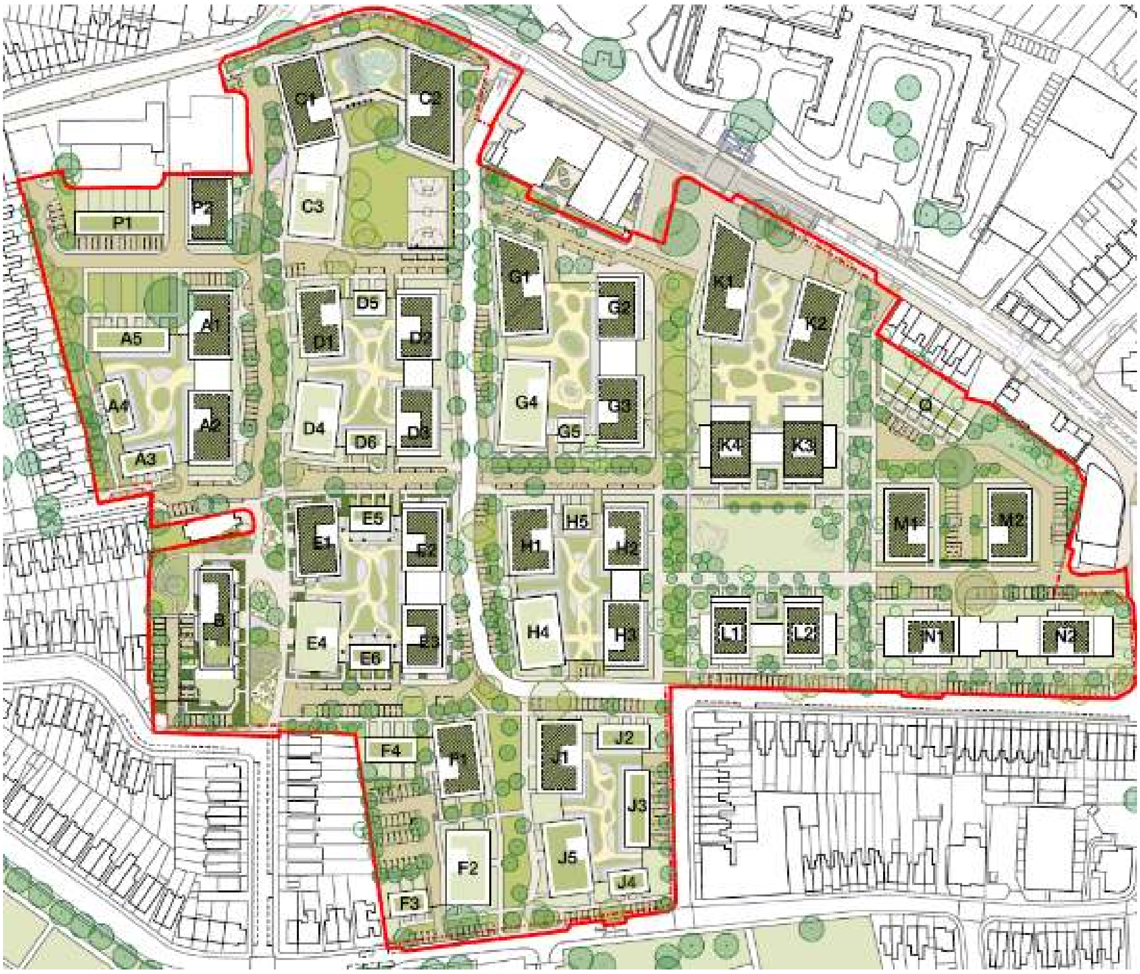


Figure 12: Indicative roof plan with PV area maximised

## $CO_2$ Emissions Following *Be Green* Measures

**7.16** Table 14, below, shows the expected Regulated $CO_2$ emissions following the inclusion of the proposed *Be Green* measures. A summary of these results can be found in Appendix N with full DER worksheets and BRUKL in Appendix N and O respectively. As shown, these result in a total 62% reduction over the *Be Lean* stage.

**Table 14: Regulated Carbon Dioxide Emissions at *Be Green* Stage**

| | **Stage** | *SAP 10.0 Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum)* | | |
|---|---|---|---|---|
| | | **Residential** | **Non-Residential** | ***Cumulative*** |
| Detailed | Baseline | 450 | 16 | 466 |
| | After *Be Lean* Measures | 390 | 13 | 403 |
| | After *Be Clean* Measures | 176 | 13 | 189 |
| | After *Be Green* Measures | 166 | 9 | 175 |
| | **Total Emissions Reduction** | 283 | 8 | 291 |
| | **Percentage Reduction after *Be Green*** | 63% | 47% | 62% |
| Outline | Baseline | 1,698 | 16 | 1,714 |
| | After *Be Lean* Measures | 1,470 | 13 | 1,483 |
| | After *Be Clean* Measures | 663 | 13 | 676 |
| | After *Be Green* Measures | 626 | 9 | 635 |
| | **Total Emissions Reduction** | 1,072 | 8 | 1,080 |
| | **Percentage Reduction after *Be Green*** | 63% | 47% | 63% |
| Entire | Baseline | 2,148 | 33 | 2,180 |
| | After *Be Lean* Measures | 1,860 | 26 | 1,886 |
| | After *Be Clean* Measures | 839 | 26 | 865 |
| | After *Be Green* Measures | 792 | 17 | 810 |
| | **Total Emissions Reduction** | **1,355** | **15** | **1,371** |
| | **Percentage Reduction after *Be Green*** | **63%** | **47%** | **63%** |

# 8. BE SEEN: ENERGY MONITORING

**8.1** The Intend to Publish London Plan introduces a fourth stage to the energy hierarchy; the ***Be Seen*** stage, which proposes monitoring and reporting of the actual operational energy performance of major developments for at least five years.

**8.2** An effectively implemented post-construction monitoring regime can have several benefits including environmental (e.g. reduced grid infrastructure strain, carbon emissions reduction) and socio-economic (e.g. reduced occupants bills and raised awareness around energy use).

**8.3** The ***Be Seen*** stage aims to monitor that the actual energy and carbon performance of buildings is aligned with the estimate figures. This is expected to assist with achieving a zero-carbon London.

**8.4** The full details of this stage are still to be consulted on and therefore have not been transposed into policy. However, standard monitoring of the Energy Centre and heat network will be undertaken during operation. It is expected that the following will be metered:

> Gas, electricity, and water used in the Energy Centre;

> Heat leaving the Energy Centre;

> Heat entering each block;

> Final customer heat consumption.

**8.5** The metering and controls strategy will be further developed during the detailed design process.

# 9. ZERO CARBON HOMES

**9.1** London Plan policy requires that all major residential developments are subject to an additional offset payment to meet a 100% reduction in Regulated $CO_2$ emissions to achieve the standard of *Zero Carbon.* This payment is made to the local borough's Carbon Offsetting Fund and is expected to be allocated to carbon reduction savings elsewhere in the borough.

**9.2** There is currently no requirement for non-residential development to meet the *Zero Carbon* target.

**9.3** The current adopted GLA carbon offsetting policy sets the offset payment price for residential development at £60 per tonne of Regulated $CO_2$ per year, for a period of 30 years.

**9.4** The estimated remaining residential Regulated $CO_2$ emissions after the ***Be Lean***, ***Be Clean*** and ***Be Green*** stages are described below in Table 15 for detailed, outline and entire development.

**9.5** These calculations should be refined at each detailed stage of the development.

**Table 15 Shortfall in Regulated Carbon dioxide emission savings ($TCO_2$)**

| | | Annual | Over 30 years |
|---|---|---|---|
| Detailed | Domestic shortfall to Zero Carbon | 166 | 4,988 |
| | Non-Domestic shortfall to 35% improvement | 0 | 0 |
| | **Cash in lieu payment (£60/TCO2)** | | £299,271 |
| Outline | Domestic shortfall to Zero Carbon | 626 | 18,785 |
| | Non-Domestic shortfall to 35% improvement | 0 | 0 |
| | **Cash in lieu payment (£60/TCO2)** | | £1,127,085 |
| Entire | Domestic shortfall to Zero Carbon | 792 | 23,773 |
| | Non-Domestic shortfall to 35% improvement | 0 | 0 |
| | **Cash in lieu payment (£60/TCO2)** | | £1,426,356 |

# 10. SUMMARY

**10.1** The purpose of this Energy Statement is to demonstrate the commitments, key measures and $CO_2$ reductions identified at each stage of the energy strategy for the proposed Cambridge Road Estate development in the Royal Borough of Kingston Upon Thames.

**10.2** This energy strategy has been formulated following the London Plan Energy Hierarchy: ***Be Lean***, ***Be Clean*** and ***Be Green***. The objective in the formulation of the strategy is to maximise the reductions in $CO_2$ emissions through the application of this Hierarchy with a cost-effective approach that is technically appropriate.

**10.3** The development summarised in this application concerns:

> Hybrid Outline Planning Application for a mixed use development, including demolition of existing buildings and erection of up to 2,170 residential units (Use Class C3), 290 $m^2$ of flexible office floorspace (Use Class E), 1,395 $m^2$ of flexible retail/commercial floorspace (Use Class E/Sui Generis), 1,250 $m^2$ community floorspace (Use Class F2);

> Detailed permission is sought for access, layout, scale, appearance and landscaping of Phase 1 for erection of 452 residential units (Use Class C3), 1,250 $m^2$ community floorspace (Use Class F2), 290 $m^2$ of flexible office floorspace (Use Class E), 395 $m^2$ of flexible retail/commercial floorspace (Use Class E/Sui Generis), new publicly accessible open space and associated access, servicing, parking, landscaping works including tree removal, refuse/recycling and bicycle storage, energy centre and works.

**10.4** Following an examination of both local and national policy requirements, it has been determined that the proposed development is to target a reduction in $CO_2$ emissions of 35% beyond a determined Part L 2013 baseline case on site. For the purposes of this Energy Statement the SAP 10.0 carbon factors are to be utilised.

**10.5** A range of ***Be Lean*** energy efficiency measures are proposed for the dwellings and Non-residential areas. This is in line with the London Plan Energy Hierarchy. They enable the proposed elements to meet the 10% and 15% improvement required from the residential and non-residential baseline cases, respectively, through energy efficiency alone. They further achieve the proposed requirements of the Draft London Plan by meeting the targeted energy efficiency requirements for this stage.

**10.6** In accordance with the Energy Hierarchy, the feasibility of heating infrastructure as a ***Be Clean*** measure has also been carefully examined. Following a site analysis, a site wide heating network with a plant room located at the base of Block E will be present. This is to enable the connection to the wider heat network that is being developed by the Royal Borough of Kingston Upon Thames. This heat network is expected to utilise heat pumps for heat generation. This development is intended to be the anchor site and is likely to be connected to this wider network. This achieves the onsite carbon reductions (35%) required by Policy SI 2 of the Intend to Publish new London Plan.

**10.7** In accordance with the Energy Hierarchy, the relevant **Be Green** renewable energy generating technologies have been evaluated. In line with Policy SI 2 renewables have been maximised through the application of low carbon heating and where safely and practicably feasible, application of photovoltaics.

**10.8** The proposed design for the development will enable it to reduce its $CO_2$ emissions and go beyond the requirements of the London Plan representing a high level of sustainable design.

**10.9** The onsite carbon emission reductions required by the London Plan have been achieved. The remaining carbon emissions are described in Table 4.

**10.10** The tables below demonstrate the reduction in Regulated and Total $CO_2$ reductions after each stage of the Energy Hierarchy showing energy policy requirements have been achieved. They are based on SAP 10.0 carbon factors.

**Table 16: Residential Carbon Dioxide Emissions and Savings after each stage of the Energy Hierarchy**

| **Stage** | **Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum)** | |
|---|---|---|
| | **Regulated** | **Unregulated** |
| Baseline: Part L 2013 Compliant Development | 2,148 | 1,225 |
| After *Be Lean* Measures | 1,860 | 1,225 |
| After *Be Clean* Measures | 839 | 1,225 |
| After *Be Green* Measures | 792 | 1,225 |
| **Stage** | **Regulated Carbon Dioxide Savings** | |
| | **Tonnes $CO_2$ per Annum** | **Percentage** |
| Savings from *Be Lean* Measures | 288 | 13% |
| Savings from *Be Clean* Measures | 1,021 | 48% |
| Savings from *Be Green* Measures | 46 | 2% |
| **Cumulative On-Site Savings** | **1,355** | 63% |

**Table 17: Non- Residential Carbon Dioxide Emissions and Savings after each stage of the Energy Hierarchy**

| **Stage** | **Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum)** | |
|---|---|---|
| | **Regulated** | **Unregulated** |
| Baseline: Part L 2013 Compliant Development | 33 | 7 |
| After *Be Lean* Measures | 26 | 7 |
| After *Be Clean* Measures | 26 | 7 |
| After *Be Green* Measures | 17 | 7 |
| **Stage** | **Regulated Carbon Dioxide Savings** | |
| | **Tonnes $CO_2$ per Annum** | **Percentage** |
| Savings from *Be Lean* Measures | 6 | 20% |
| Savings from *Be Clean* Measures | 0 | 0% |
| Savings from *Be Green* Measures | 9 | 28% |
| **Cumulative On-Site Savings** | **15** | 47% |

**Table 18: Site Wide Carbon Dioxide Emissions and Cumulative Savings**

| **Stage** | **Regulated Carbon Dioxide Emissions (Tonnes $CO_2$ per Annum)** | **Regulated Carbon Dioxide Savings** | |
|---|---|---|---|
| | | **Tonnes $CO_2$ per Annum** | **Percentage** |
| Baseline: Part L 2013 Compliant Development | 2,180 | | |
| After ***Be Lean*** Measures | 1,886 | 294 | 14% |
| After ***Be Clean*** Measures | 865 | 1,021 | 47% |
| After ***Be Green*** Measures | 810 | 55 | 3% |
| **Cumulative On-Site Savings** | | **1,371** | 63% |

**Table 19 Shortfall in Regulated Carbon dioxide emission savings (TCO$_2$)**

| | | Annual | Over 30 years |
|---|---|---|---|
| Detailed | Domestic shortfall to Zero Carbon | 166 | 4,988 |
| | Non-Domestic shortfall to 35% improvement | 0 | 0 |
| | **Cash in lieu payment (£60/TCO2)** | | £299,271 |
| Outline | Domestic shortfall to Zero Carbon | 626 | 18,785 |
| | Non-Domestic shortfall to 35% improvement | 0 | 0 |
| | **Cash in lieu payment (£60/TCO2)** | | £1,127,085 |
| Entire | Domestic shortfall to Zero Carbon | 792 | 23,773 |
| | Non-Domestic shortfall to 35% improvement | 0 | 0 |
| | **Cash in lieu payment (£60/TCO2)** | | £1,426,356 |

# APPENDICES

**Appendix A $CO_2$ Emissions Summary – Be Lean**

**Appendix B TER Worksheets**

**Appendix C DER Worksheets –** ***Be Lean***

**Appendix D BRUKL –** ***Be Lean***

**Appendix E Dynamic Overheating Assessment**

**Appendix F Whole Life Cycle Carbon Assessment**

**Appendix G Indicative Energy Centre Layouts (GA / Section)**

**Appendix H Preferred energy strategy - Indicative Energy Centre Layouts, Connection, Heat network Layout**

**Appendix I Alternative energy strategy - Indicative Energy Centre Layouts, Connection, Heat network Layout**

**Appendix J $CO_2$ Emissions Summary –** ***Be Clean***

**Appendix K DER Worksheets –** ***Be Clean***

**Appendix L Indicative PV Locations**

**Appendix M BREEAM ENE 04 review**

**Appendix N $CO_2$ Emissions Summary –** ***Be Green***

**Appendix O DER Worksheets –** ***Be Green***

**Appendix P BRUKL –** ***Be Green***

**Appendix Q $CO_2$ Emissions Summary –** ***Be Green- Alternative energy strategy***

# Appendix A CO2 Emissions Summary – Be Lean

The applicant should complete all the light blue cells including information on the 'be lean' energy consumption figures, the 'be lean' DER, the DFEE and the regulated energy demand of the 'be lean' scenario.

## DOMESTIC ENERGY CONSUMPTION AND CO₂ ANALYSIS

| Unit identifier (e.g. plot number, dwelling type etc.) | Model total floor area (m²) | Number of units | Total area represented by model (m²) | VALIDATION CHECK | | REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE LEAN' SAP DER WORKSHEET | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Calculated DER 2012 (kgCO2 / m2) | DER Worksheet DER 2012 (kgCO2 / m2) | Space Heating | Fuel type Space Heating | Domestic Hot Water | Fuel type Domestic Hot Water | Lighting | Auxiliary | Cooling |
| | | | | | DER Sheet (Row 384) | DER Sheet [(Row 307a) ÷ (Row 367a x 0.01)] | Select fuel type | DER Sheet [(Row 310a) ÷ (Row 367a x 0.01)] | Select fuel type | DER Sheet Row 332 | DER Sheet (Row 313 + 331) | DER Sheet Row 315 |
| 1B2P - Ground Flo | 51.12 | 17 | 869.04 | 17.5 | 17.5 | 1468.815642 | Natural Gas | 1763.843575 | Natural Gas | 246.61 | 130.8446 | |
| 1B2P - Mid Floor | 50.88 | 131 | 6665.28 | 16.2 | 16.2 | 1157.631285 | Natural Gas | 1760.73743 | Natural Gas | 247.99 | 127.6856 | |
| 1B2P - Top Floor B | 50.32 | 17 | 855.44 | 16.9 | 16.9 | 1290.100559 | Natural Gas | 1753.50838 | Natural Gas | 244.38 | 127.6231 | |
| 2B3P - Top Floor B | 64.62 | 53 | 3424.86 | 19.5 | 19.5 | 2756.603352 | Natural Gas | 1932.927374 | Natural Gas | 290.37 | 187.7927 | |
| 2B4P - Mid Floor | 73.74 | 106 | 7816.44 | 14.4 | 14.4 | 1660.960894 | Natural Gas | 2031.396648 | Natural Gas | 325.11 | 180.4729 | |
| 2B4P - Mid Floor B | 74 | 106 | 7844 | 14.1 | 14.1 | 1528.011173 | Natural Gas | 2033.932961 | Natural Gas | 325.04 | 199.6414 | |
| 3B4P - Top Floor | 72.42 | 4 | 289.68 | 16.0 | 16.0 | 2143.407821 | Natural Gas | 2018.24581 | Natural Gas | 320.59 | 181.8032 | |
| 3B5P - Ground Flo | 104.07 | 4 | 416.28 | 15.0 | 15.0 | 3292.793296 | Natural Gas | 2224.614525 | Natural Gas | 425.01 | 285.0893 | |
| 3B6P - Top Floor | 94.73 | 7 | 663.11 | 15.4 | 15.4 | 2967.452514 | Natural Gas | 2185.575419 | Natural Gas | 408.17 | 260.6134 | |
| 4P8P - Duplex | 129.44 | 7 | 906.08 | 12.8 | 12.8 | 3309.117318 | Natural Gas | 2276.949721 | Natural Gas | 476.33 | 397.9946 | |
| Sum | 29,750 | 452 | 29,750 | 15.5 | - | 748,363 | N/A | 872,031 | N/A | 134,313 | 77,844 | 0 |

| Unit identifier (e.g. plot number, dwelling type etc.) | SAP 2012 CO2 PERFORMANCE<br>REGULATED CO2 EMISSIONS PER UNIT (kgCO2 p.a.) | | | | | | SAP10 CO2 PERFORMANCE<br>REGULATED CO2 EMISSIONS PER UNIT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Space Heating | Domestic Hot Water | Lighting | Auxiliary | Cooling | 2012 CO2 emissions (kgCO2 p.a.) | Space Heating CO2 emissions (kgCO2 p.a.) | Domestic Hot Water CO2 emissions (kgCO2 p.a.) | Lighting CO2 emissions (kgCO2 p.a.) | Auxiliary CO2 emissions (kgCO2 p.a.) | Cooling CO2 emissions (kgCO2 p.a.) | SAP10 CO2 emissions (kgCO2 p.a.) | Calculated DER SAP10 (kgCO2 / m2) |
| 1B2P - Ground Flo | 317 | 381 | 128 | 68 | | 894 | 308 | 370 | 57 | 30 | | 767 | 15.0 |
| 1B2P - Mid Floor | 250 | 380 | 129 | 66 | | 825 | 243 | 370 | 58 | 30 | | 700 | 13.8 |
| 1B2P - Top Floor B | 279 | 379 | 127 | 66 | | 850 | 271 | 368 | 57 | 30 | | 726 | 14.4 |
| 2B3P - Top Floor B | 595 | 418 | 151 | 97 | | 1,261 | 579 | 406 | 68 | 44 | | 1,096 | 17.0 |
| 2B4P - Mid Floor | 359 | 439 | 169 | 94 | | 1,060 | 349 | 427 | 76 | 42 | | 893 | 12.1 |
| 2B4P - Mid Floor B | 330 | 439 | 169 | 104 | | 1,042 | 321 | 427 | 76 | 47 | | 870 | 11.8 |
| 3B4P - Top Floor | 463 | 436 | 166 | 94 | | 1,160 | 450 | 424 | 75 | 42 | | 991 | 13.7 |
| 3B5P - Ground Flo | 711 | 481 | 221 | 148 | | 1,560 | 691 | 467 | 99 | 66 | | 1,324 | 12.7 |
| 3B6P - Top Floor | 641 | 472 | 212 | 135 | | 1,460 | 623 | 459 | 95 | 61 | | 1,238 | 13.1 |
| 4P8P - Duplex | 715 | 492 | 247 | 207 | | 1,660 | 695 | 478 | 111 | 93 | | 1,377 | 10.6 |
| Sum | 161,646 | 188,359 | 69,708 | 40,401 | 0 | *460,114* | 157,156 | 183,126 | 31,295 | 18,138 | 0 | *389,715* | 13.1 |

## DOMESTIC ENERGY DEMAND DATA

| Unit identifier (e.g. plot number, dwelling type etc.) | Fabric Energy Efficiency (FEE) | REGULATED ENERGY DEMAND PER UNIT PER ANNUM (kWh p.a.) | | | | |
|---|---|---|---|---|---|---|
| | Dwelling Fabric Energy Efficiency (DFEE) (kWh/m²) | Space Heating (kWh p.a.) | Domestic Hot Water (kWh p.a.) | Lighting (kWh p.a.) | Auxiliary (kWh p.a.) | Cooling (kWh p.a.) |
| 1B2P - Ground Flo | 44.19359212 | 1,469 | 1,764 | 247 | 131 | |
| 1B2P - Mid Floor | 39.61558444 | 1,158 | 1,761 | 248 | 128 | |
| 1B2P - Top Floor B | 41.94122884 | 1,290 | 1,754 | 244 | 128 | |
| 2B3P - Top Floor B | 54.95205384 | 2,757 | 1,933 | 290 | 188 | |
| 2B4P - Mid Floor | 38.10234839 | 1,661 | 2,031 | 325 | 180 | |
| 2B4P - Mid Floor B | 36.50798889 | 1,528 | 2,034 | 325 | 200 | |
| 3B4P - Top Floor | 44.18403989 | 2,143 | 2,018 | 321 | 182 | |
| 3B5P - Ground Flo | 44.76788586 | 3,293 | 2,225 | 425 | 285 | |
| 3B6P - Top Floor | 44.22994758 | 2,967 | 2,186 | 408 | 261 | |
| 4P8P - Duplex | 38.18792267 | 3,309 | 2,277 | 476 | 398 | |
| Sum | 40.54 | 748,363 | 872,031 | 134,313 | 77,844 | 0 |

## NON-DOMESTIC ENERGY CONSUMPTION AND CO₂ ANALYSIS

| Building Use | Area per unit (m²) | Number of units | Total area represented by model (m²) | VALIDATION CHECK | | REGULATED ENERGY CONSUMPTION BY END USE (kWh/m² p.a.) 'BE LEAN' BER - SOURCE: BRUKL OUTPUT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Calculated BER 2012 (kgCO2 / m2) | BRUKL BER 2012 (kgCO2 / m2) | Space Heating (kWh/m² p.a.) | Fuel type Space Heating | Domestic Hot Water (kWh/m² p.a.) | Fuel type Domestic Hot Water | Lighting (kWh/m² p.a.) | Auxiliary (kWh/m² p.a.) | Cooling (kWh/m² p.a.) |
| Commercial | 1935 | 1 | 2474.4 | 8.8 | 8.8 | 11.1 | Natural Gas | 0.46 | Natural Gas | 7.72 | 2.23 | 2.29 |
| Sum | 1,935 | 1 | 2,474 | 11.3 | - | 21,479 | N/A | 890 | N/A | 14,938 | 4,315 | 4,431 |

| Building Use | LATED ENERGY CONSUMPTION BY FUEL TYPE (kWh/m² p.a.) 'BE LEAN' BER - SOURCE: BRUKL.INP or *SIM.CSV | | | | | | REGULATED CO2 EMISSIONS PER UNIT | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Natural Gas | Grid Electricity | | | | 2012 CO2 emissions (kgCO2 p.a.) | Natural Gas | Grid Electricity | | SAP10 CO2 emissions (kgCO2 p.a.) | BRUKL BER SAP10 (kgCO2 / m2) |
| | ############## | ############## | | | | | ############## | ############## | | | |
| Commercial | 12 | 12 | | | | 17,124 | 12 | 12 | | 10,216 | 5.3 |
| Sum | 12 | 12 | N/A | N/A | N/A | *21,897* | 12 | 12 | | *13,064* | 6.8 |

## NON-DOMESTIC ENERGY DEMAND

| Building Use | | REGULATED ENERGY DEMAND PER UNIT PER ANNUM (kWh p.a.) | | | | |
|---|---|---|---|---|---|---|
| | | Space Heating (kWh p.a.) | Domestic Hot Water (kWh p.a.) | Lighting (kWh p.a.) | Auxiliary (kWh p.a.) | Cooling (kWh p.a.) |
| Commercial | N/A | 21,479 | 890 | 14,938 | 4,315 | 4,431 |
| Sum | | 21,479 | 890 | 14,938 | 4,315 | 4,431 |

## SITE-WIDE ENERGY CONSUMPTION AND CO₂ ANALYSIS

| Use | Total Area (m²) | Calculated BER 2012 (kgCO2 / m2) | - | REGULATED ENERGY CONSUMPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Space Heating (kWh p.a.) | N/A | Domestic Hot Water (kWh p.a.) | N/A | Lighting (kWh p.a.) | Auxiliary (kWh p.a.) | Cooling (kWh p.a.) |
| Sum | 32,225 | 15.0 | - | 769,842 | | 872,921 | | 149,251 | 82,159 | 4,431 |

| Use | | REGULATED CO2 EMISSIONS | | REGULATED CO2 EMISSIONS | | | REGULATED ENERGY DEMAND PER UNIT PER ANNUM (kWh p.a.) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 2012 CO2 emissions (kgCO2 p.a.) | | SAP10 CO2 emissions (kgCO2 p.a.) | Calculated BER SAP10 (kgCO2 / m2) | N/A | Space Heating (kWh p.a.) | Domestic Hot Water (kWh p.a.) | Lighting (kWh p.a.) | Auxiliary (kWh p.a.) | Cooling (kWh p.a.) |
| Sum | | *482,012* | | *402,779* | 12.5 | | 769,842 | 872,921 | 149,251 | 82,159 | 4,431 |

The applicant should complete all the light blue cells including information on the 'be lean' energy consumption figures, the 'be lean' DER, the DFEE and the regulated energy demand of the 'be lean' scenario.

SAP 2012 CO2 PERFORMANCE

SAP10 CO2 PERFORMANCE

## DOMESTIC ENERGY CONSUMPTION AND $CO_2$ ANALYSIS

| Unit identifier (e.g. plot number, dwelling type etc.) | Model total floor area (m²) | Number of units | Total area represented by model (m²) | VALIDATION CHECK | | REGULATED ENERGY CONSUMPTION PER UNIT (kWh p.a.) - 'BE LEAN' SAP DER WORKSHEET | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Calculated DER 2012 (kgCO2 / m2) | DER Worksheet DER 2012 (kgCO2 / m2) | Space Heating | Fuel type Space Heating | Domestic Hot Water | Fuel type Domestic Hot Water | Lighting | Auxiliary | Cooling |
| | | | | | DER Sheet (Row 384) | DER Sheet [(Row 307a) ÷ (Row 367a x 0.01)] | Select fuel type | DER Sheet [(Row 310a) ÷ (Row 367a x 0.01)] | Select fuel type | DER Sheet Row 332 | DER Sheet (Row 313 + 331) | DER Sheet Row 315 |
| 1B2P - Ground Flo | 51.12 | 71 | 869.04 | 17.5 | 17.5 | 1468.815642 | Natural Gas | 1763.843575 | Natural Gas | 246.61 | 130.8446 | |
| 1B2P - Mid Floor | 50.88 | 566 | 6665.28 | 16.2 | 16.2 | 1157.631285 | Natural Gas | 1760.73743 | Natural Gas | 247.99 | 127.6856 | |
| 1B2P - Top Floor B | 50.32 | 71 | 855.44 | 16.9 | 16.9 | 1290.100559 | Natural Gas | 1753.50838 | Natural Gas | 244.38 | 127.6231 | |
| 2B3P - Top Floor B | 64.62 | 178 | 3424.86 | 19.5 | 19.5 | 2756.603352 | Natural Gas | 1932.927374 | Natural Gas | 290.37 | 187.7927 | |
| 2B4P - Mid Floor | 73.74 | 356 | 7816.44 | 14.4 | 14.4 | 1660.960894 | Natural Gas | 2031.396648 | Natural Gas | 325.11 | 180.4729 | |
| 2B4P - Mid Floor B | 74 | 356 | 7844 | 14.1 | 14.1 | 1528.011173 | Natural Gas | 2033.932961 | Natural Gas | 325.04 | 199.6414 | |
| 3B4P - Top Floor | 72.42 | 41 | 289.68 | 16.0 | 16.0 | 2143.407821 | Natural Gas | 2018.24581 | Natural Gas | 320.59 | 181.8032 | |
| 3B5P - Ground Flo | 104.07 | 41 | 416.28 | 15.0 | 15.0 | 3292.793296 | Natural Gas | 2224.614525 | Natural Gas | 425.01 | 285.0893 | |
| 3B6P - Top Floor | 94.73 | 19 | 663.11 | 15.4 | 15.4 | 2967.452514 | Natural Gas | 2185.575419 | Natural Gas | 408.17 | 260.6134 | |
| 4P8P - Duplex | 129.44 | 19 | 906.08 | 12.8 | 12.8 | 3309.117318 | Natural Gas | 2276.949721 | Natural Gas | 476.33 | 397.9946 | |
| Sum | 111,593 | 1,718 | 29,750 | 4.1 | - | 2,819,191 | N/A | 3,296,373 | N/A | 505,737 | 291,025 | 0 |

| Unit identifier (e.g. plot number, dwelling type etc.) | REGULATED CO2 EMISSIONS PER UNIT (kgCO2 p.a.) | | | | | | REGULATED CO2 EMISSIONS PER UNIT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Space Heating | Domestic Hot Water | Lighting | Auxiliary | Cooling | 2012 CO2 emissions (kgCO2 p.a.) | Space Heating CO2 emissions (kgCO2 p.a.) | Domestic Hot Water CO2 emissions (kgCO2 p.a.) | Lighting CO2 emissions (kgCO2 p.a.) | Auxiliary CO2 emissions (kgCO2 p.a.) | Cooling CO2 emissions (kgCO2 p.a.) | SAP10 CO2 emissions (kgCO2 p.a.) | Calculated DER SAP10 (kgCO2 / m2) |
| 1B2P - Ground Flo | 317 | 381 | 128 | 68 | | 894 | 308 | 370 | 57 | 30 | | 767 | 15.0 |
| 1B2P - Mid Floor | 250 | 380 | 129 | 66 | | 825 | 243 | 370 | 58 | 30 | | 700 | 13.8 |
| 1B2P - Top Floor B | 279 | 379 | 127 | 66 | | 850 | 271 | 368 | 57 | 30 | | 726 | 14.4 |
| 2B3P - Top Floor B | 595 | 418 | 151 | 97 | | 1,261 | 579 | 406 | 68 | 44 | | 1,096 | 17.0 |
| 2B4P - Mid Floor | 359 | 439 | 169 | 94 | | 1,060 | 349 | 427 | 76 | 42 | | 893 | 12.1 |
| 2B4P - Mid Floor B | 330 | 439 | 169 | 104 | | 1,042 | 321 | 427 | 76 | 47 | | 870 | 11.8 |
| 3B4P - Top Floor | 463 | 436 | 166 | 94 | | 1,160 | 450 | 424 | 75 | 42 | | 991 | 13.7 |
| 3B5P - Ground Flo | 711 | 481 | 221 | 148 | | 1,560 | 691 | 467 | 99 | 66 | | 1,324 | 12.7 |
| 3B6P - Top Floor | 641 | 472 | 212 | 135 | | 1,460 | 623 | 459 | 95 | 61 | | 1,238 | 13.1 |
| 4P8P - Duplex | 715 | 492 | 247 | 207 | | 1,660 | 695 | 478 | 111 | 93 | | 1,377 | 10.6 |
| Sum | 608,945 | 712,017 | 262,477 | 151,042 | 0 | 460,114 | 592,030 | 692,238 | 117,837 | 67,809 | 0 | 389,715 | 3.5 |

## DOMESTIC ENERGY DEMAND DATA

| Unit identifier (e.g. plot number, dwelling type etc.) | Fabric Energy Efficiency (FEE) | REGULATED ENERGY DEMAND PER UNIT PER ANNUM (kWh p.a.) | | | | |
|---|---|---|---|---|---|---|
| | Dwelling Fabric Energy Efficiency (DFEE) (kWh/m²) | Space Heating (kWh p.a.) | Domestic Hot Water (kWh p.a.) | Lighting (kWh p.a.) | Auxiliary (kWh p.a.) | Cooling (kWh p.a.) |
| 1B2P - Ground Flo | 44.19359212 | 1,469 | 1,764 | 247 | 131 | |
| 1B2P - Mid Floor | 39.61558444 | 1,158 | 1,761 | 248 | 128 | |
| 1B2P - Top Floor B | 41.94122884 | 1,290 | 1,754 | 244 | 128 | |
| 2B3P - Top Floor B | 54.95205384 | 2,757 | 1,933 | 290 | 188 | |
| 2B4P - Mid Floor | 38.10234839 | 1,661 | 2,031 | 325 | 180 | |
| 2B4P - Mid Floor B | 36.50798889 | 1,528 | 2,034 | 325 | 200 | |
| 3B4P - Top Floor | 44.18403989 | 2,143 | 2,018 | 321 | 182 | |
| 3B5P - Ground Flo | 44.76788586 | 3,293 | 2,225 | 425 | 285 | |
| 3B6P - Top Floor | 44.22994758 | 2,967 | 2,186 | 408 | 261 | |
| 4P8P - Duplex | 38.18792267 | 3,309 | 2,277 | 476 | 398 | |
| Sum | 40.69 | 2,819,191 | 3,296,373 | 505,737 | 291,025 | 0 |

## NON-DOMESTIC ENERGY CONSUMPTION AND $CO_2$ ANALYSIS

| Building Use | Area per unit (m²) | Number of units | Total area represented by model (m²) | VALIDATION CHECK | | REGULATED ENERGY CONSUMPTION BY END USE (kWh/m² p.a.) 'BE LEAN' BER - SOURCE: BRUKL OUTPUT | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Calculated BER 2012 (kgCO2 / m2) | BRUKL BER 2012 (kgCO2 / m2) | Space Heating (kWh/m² p.a.) | Fuel type Space Heating | Domestic Hot Water (kWh/m² p.a.) | Fuel type Domestic Hot Water | Lighting (kWh/m² p.a.) | Auxiliary (kWh/m² p.a.) | Cooling (kWh/m² p.a.) |
| Commercial | 1000 | 1 | 2474.4 | 8.8 | 8.8 | 11.1 | Natural Gas | 0.46 | Natural Gas | 7.72 | 2.23 | 2.29 |
| Sum | 1,000 | 1 | 2,474 | 21.9 | - | 11,100 | N/A | 460 | N/A | 7,720 | 2,230 | 2,290 |

| Building Use | LATED ENERGY CONSUMPTION BY FUEL TYPE (kWh/m² p.a.) 'BE LEAN' BER - SOURCE: BRUKL.INP or *SIM.CS | | | | | | REGULATED CO2 EMISSIONS PER UNIT | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Natural Gas | Grid Electricity | | | | 2012 CO2 emissions (kgCO2 p.a.) | Natural Gas | Grid Electricity | | SAP10 CO2 emissions (kgCO2 p.a.) | BRUKL BER SAP10 (kgCO2 / m2) |
| | ############## | ############## | | | | | ############## | ############## | | | |
| Commercial | 12 | 12 | | | | 8,850 | 12 | 12 | | 5,280 | 5.3 |
| Sum | 12 | 12 | N/A | N/A | N/A | 21,897 | 12 | 12 | | 13,064 | 13.1 |

## NON-DOMESTIC ENERGY DEMAND

| Building Use | | REGULATED ENERGY DEMAND PER UNIT PER ANNUM (kWh p.a.) | | | | |
|---|---|---|---|---|---|---|
| | | Space Heating (kWh p.a.) | Domestic Hot Water (kWh p.a.) | Lighting (kWh p.a.) | Auxiliary (kWh p.a.) | Cooling (kWh p.a.) |
| Commercial | N/A | 11,100 | 460 | 7,720 | 2,230 | 2,290 |
| Sum | | 11,100 | 460 | 7,720 | 2,230 | 2,290 |

## SITE-WIDE ENERGY CONSUMPTION AND $CO_2$ ANALYSIS

| Use | Total Area (m²) | Calculated BER 2012 (kgCO2 / m2) | - | REGULATED ENERGY CONSUMPTION | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Space Heating (kWh p.a.) | N/A | Domestic Hot Water (kWh p.a.) | N/A | Lighting (kWh p.a.) | Auxiliary (kWh p.a.) | Cooling (kWh p.a.) |
| Sum | 32,225 | 15.0 | - | 2,830,291 | | 3,296,833 | | 513,457 | 293,255 | 2,290 |

| Use | REGULATED CO2 EMISSIONS | REGULATED CO2 EMISSIONS | | | REGULATED ENERGY DEMAND PER UNIT PER ANNUM (kWh p.a.) | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2012 CO2 emissions (kgCO2 p.a.) | SAP10 CO2 emissions (kgCO2 p.a.) | Calculated BER SAP10 (kgCO2 / m2) | N/A | Space Heating (kWh p.a.) | Domestic Hot Water (kWh p.a.) | Lighting (kWh p.a.) | Auxiliary (kWh p.a.) | Cooling (kWh p.a.) |
| Sum | 482,012 | 402,779 | 12.5 | | 2,830,291 | 3,296,833 | 513,457 | 293,255 | 2,290 |

# Appendix B TER Worksheets

# TER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco  Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 1B2P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 51.12 | (1a) | x | 2.50 | (2a) | = | 127.80 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 51.12 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 127.80 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 2 | x 10 = | 20 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

| | | | | Air changes per hour | |
|---|---|---|---|---|---|
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 20 | ÷ (5) = | 0.16 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.41 | (18) |
| Number of sides on which the dwelling is sheltered | | 1 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.93 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.38 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.48 | 0.47 | 0.46 | 0.41 | 0.40 | 0.36 | 0.36 | 0.35 | 0.38 | 0.40 | 0.42 | 0.44 | (22b) |

Calculate effective air change rate for the applicable case:

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.61 | 0.61 | 0.61 | 0.59 | 0.58 | 0.56 | 0.56 | 0.56 | 0.57 | 0.58 | 0.59 | 0.60 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.61 | 0.61 | 0.61 | 0.59 | 0.58 | 0.56 | 0.56 | 0.56 | 0.57 | 0.58 | 0.59 | 0.60 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, $m^2$ | Openings $m^2$ | Net area A, $m^2$ | | U-value W/$m^2$K | | A x U W/K | κ-value, kJ/$m^2$.K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 8.18 | x | 1.33 | = | 10.84 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| Ground floor | | | 51.12 | x | 0.13 | = | 6.65 | | | (28a) |
| External wall | | | 46.40 | x | 0.18 | = | 8.35 | | | (29a) |
| Party wall | | | 17.80 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, $m^2$ | | | 107.50 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 27.64 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/$m^2$K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 7.49 | (36) |
| Total fabric heat loss | (33) + (36) = | 35.13 | (37) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25.93 | 25.75 | 25.56 | 24.69 | 24.53 | 23.78 | 23.78 | 23.64 | 24.07 | 24.53 | 24.86 | 25.20 | (38) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 61.06 | 60.87 | 60.69 | 59.82 | 59.66 | 58.91 | 58.91 | 58.77 | 59.20 | 59.66 | 59.99 | 60.33 |

Average = ∑(39)1...12/12 = 59.82 (39)

Heat loss parameter (HLP), W/$m^2$K (39)m ÷ (4)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.19 | 1.19 | 1.19 | 1.17 | 1.17 | 1.15 | 1.15 | 1.15 | 1.16 | 1.17 | 1.17 | 1.18 |

Average = ∑(40)1...12/12 = 1.17 (40)

Number of days in month (Table 1a)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 1.72 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 75.12 | (43) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 82.64 | 79.63 | 76.63 | 73.62 | 70.62 | 67.61 | 67.61 | 70.62 | 73.62 | 76.63 | 79.63 | 82.64 |

∑(44)1...12 = 901.49 (44)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 122.55 | 107.18 | 110.60 | 96.42 | 92.52 | 79.84 | 73.98 | 84.90 | 85.91 | 100.12 | 109.29 | 118.68 |

∑(45)1...12 = 1181.99 (45)

Distribution loss 0.15 x (45)m

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.38 | 16.08 | 16.59 | 14.46 | 13.88 | 11.98 | 11.10 | 12.73 | 12.89 | 15.02 | 16.39 | 17.80 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.26 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.14 | (50) |
| Enter (50) or (54) in (55) | 0.14 | (55) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 150.16 | 132.13 | 138.22 | 123.15 | 120.14 | 106.57 | 101.60 | 112.51 | 112.64 | 127.74 | 136.02 | 146.30 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 150.16 | 132.13 | 138.22 | 123.15 | 120.14 | 106.57 | 101.60 | 112.51 | 112.64 | 127.74 | 136.02 | 146.30 |

∑(64)1...12 = 1507.17 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62.84 | 55.59 | 58.87 | 53.44 | 52.86 | 47.93 | 46.69 | 50.32 | 49.95 | 55.38 | 57.72 | 61.56 | (65) |

## 5. Internal gains

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

Metabolic gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | (66) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13.96 | 12.40 | 10.09 | 7.64 | 5.71 | 4.82 | 5.21 | 6.77 | 9.08 | 11.54 | 13.46 | 14.35 | (67) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 150.14 | 151.70 | 147.77 | 139.42 | 128.87 | 118.95 | 112.32 | 110.77 | 114.69 | 123.05 | 133.60 | 143.52 | (68) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | (69) |

Pump and fan gains (Table 5a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |

Losses e.g. evaporation (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 84.46 | 82.73 | 79.12 | 74.23 | 71.05 | 66.57 | 62.76 | 67.64 | 69.37 | 74.44 | 80.17 | 82.74 | (72) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 300.42 | 298.68 | 288.83 | 273.12 | 257.47 | 242.18 | 232.14 | 237.02 | 244.99 | 260.87 | 279.08 | 292.45 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.77 | x | 8.18 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 49.10 | (80) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 49.10 | 96.05 | 158.18 | 230.69 | 282.72 | 289.42 | 275.54 | 236.68 | 183.97 | 113.97 | 61.22 | 40.38 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 349.52 | 394.73 | 447.01 | 503.82 | 540.19 | 531.60 | 507.67 | 473.70 | 428.96 | 374.84 | 340.30 | 332.83 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.94 | 0.84 | 0.67 | 0.50 | 0.56 | 0.81 | 0.97 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.78 | 19.93 | 20.20 | 20.54 | 20.82 | 20.96 | 20.99 | 20.99 | 20.89 | 20.53 | 20.09 | 19.75 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.92 | 19.93 | 19.93 | 19.94 | 19.95 | 19.96 | 19.96 | 19.96 | 19.95 | 19.95 | 19.94 | 19.94 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.92 | 0.79 | 0.58 | 0.39 | 0.44 | 0.73 | 0.95 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.31 | 18.53 | 18.92 | 19.42 | 19.77 | 19.93 | 19.96 | 19.96 | 19.87 | 19.41 | 18.78 | 18.28 | (90) |

Living area fraction Living area ÷ (4) = 0.47 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.00 | 19.19 | 19.52 | 19.95 | 20.26 | 20.41 | 20.44 | 20.44 | 20.35 | 19.93 | 19.40 | 18.97 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.00 | 19.19 | 19.52 | 19.95 | 20.26 | 20.41 | 20.44 | 20.44 | 20.35 | 19.93 | 19.40 | 18.97 | (93) |

## 8. Space heating requirement

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

Utilisation factor for gains, ηm

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.99 | 0.97 | 0.92 | 0.81 | 0.62 | 0.44 | 0.49 | 0.77 | 0.95 | 0.99 | 1.00 | (94) |

Useful gains, ηmGm, W (94)m x (84)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 347.36 | 390.15 | 434.67 | 464.89 | 436.71 | 328.08 | 224.17 | 233.70 | 328.64 | 355.89 | 336.26 | 331.19 | (95) |

Monthly average external temperature from Table U1

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 897.45 | 869.65 | 790.05 | 660.93 | 510.97 | 342.53 | 226.36 | 237.44 | 369.90 | 556.80 | 737.69 | 891.37 | (97) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 409.27 | 322.23 | 264.41 | 141.15 | 55.25 | 0.00 | 0.00 | 0.00 | 0.00 | 149.47 | 289.03 | 416.78 | |

∑(98)1...5, 10...12 = 2047.57 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 40.05 (99)

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

**Space heating**

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | | 0.00 | (201) |
| Fraction of space heat from main system(s) | 1 - (201) = | 1.00 | (202) |
| Fraction of space heat from main system 2 | | 0.00 | (202) |
| Fraction of total space heat from main system 1 | (202) x [1- (203)] = | 1.00 | (204) |
| Fraction of total space heat from main system 2 | (202) x (203) = | 0.00 | (205) |
| Efficiency of main system 1 (%) | | 93.50 | (206) |

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 437.72 | 344.63 | 282.79 | 150.96 | 59.09 | 0.00 | 0.00 | 0.00 | 0.00 | 159.86 | 309.12 | 445.75 | |

∑(211)1...5, 10...12 = 2189.92 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.36 | 87.10 | 86.52 | 85.18 | 82.89 | 79.80 | 79.80 | 79.80 | 79.80 | 85.23 | 86.78 | 87.45 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 171.90 | 151.69 | 159.76 | 144.58 | 144.94 | 133.54 | 127.32 | 140.99 | 141.15 | 149.87 | 156.74 | 167.29 | |

∑(219a)1...12 = 1789.77 (219)

**Annual totals**

Space heating fuel - main system 1 2189.92

| | | | |
|---|---|---|---|
| Water heating fuel | | 1789.77 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | (230c) |
| boiler flue fan | 45.00 | | (230e) |
| Total electricity for the above, kWh/year | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | 246.61 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 4301.30 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2189.92 | x | 3.48 | x 0.01 = | 76.21 | (240) |
| Water heating | 1789.77 | x | 3.48 | x 0.01 = | 62.28 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 246.61 | x | 13.19 | x 0.01 = | 32.53 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 300.91 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.31 | (257) |
| SAP value | 81.66 | |
| SAP rating (section 13) | 82 | (258) |
| SAP band | B | |

## 12a. CO$_2$ emissions - individual heating systems including micro-CHP

| | Energy kWh/year | | Emission factor kg CO$_2$/kWh | | Emissions kg CO$_2$/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2189.92 | x | 0.216 | = | 473.02 | (261) |
| Water heating | 1789.77 | x | 0.216 | = | 386.59 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 859.61 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 246.61 | x | 0.519 | = | 127.99 | (268) |
| Total CO$_2$, kg/year | | | | (265)...(271) = | 1026.53 | (272) |
| Dwelling CO$_2$ emission rate | | | | (272) ÷ (4) = | 20.08 | (273) |
| EI value | | | | | 85.69 | |
| EI rating (section 14) | | | | | 86 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2189.92 | x | 1.22 | = | 2671.70 | (261) |
| Water heating | 1789.77 | x | 1.22 | = | 2183.52 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 4855.22 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 246.61 | x | 3.07 | = | 757.11 | (268) |
| Primary energy kWh/year | | | | | 5842.57 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 114.29 | (273) |

# TER Worksheet
## Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 1B2P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 50.88 | (1a) | x | 2.50 | (2a) | = | 127.20 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 50.88 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 127.20 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 2 | x 10 = | 20 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |
| | | | Air changes per hour | |
| Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) = | 20 | ÷ (5) = | 0.16 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.41 | (18) |
| Number of sides on which the dwelling is sheltered | | 3 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.78 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.32 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.40 | 0.39 | 0.39 | 0.35 | 0.34 | 0.30 | 0.30 | 0.29 | 0.32 | 0.34 | 0.36 | 0.37 | (22b) |

Calculate effective air change rate for the applicable case:

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.58 | 0.58 | 0.57 | 0.56 | 0.56 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.58 | 0.58 | 0.57 | 0.56 | 0.56 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 7.76 | x | 1.33 | = | 10.29 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| External wall | | | 51.45 | x | 0.18 | = | 9.26 | | | (29a) |
| Party wall | | | 11.68 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 61.01 | | | | | | | (31) |

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 21.35 (33)

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

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

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 5.08 (36)

Total fabric heat loss (33) + (36) = 26.43 (37)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 24.39 | 24.25 | 24.13 | 23.52 | 23.40 | 22.87 | 22.87 | 22.78 | 23.08 | 23.40 | 23.63 | 23.87 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 50.81 | 50.68 | 50.55 | 49.95 | 49.83 | 49.30 | 49.30 | 49.20 | 49.51 | 49.83 | 50.06 | 50.30 | |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.00 | 1.00 | 0.99 | 0.98 | 0.98 | 0.97 | 0.97 | 0.97 | 0.97 | 0.98 | 0.98 | 0.99 | |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

Average = ∑(39)1...12/12 = 49.94 (39)

Average = ∑(40)1...12/12 = 0.98 (40)

## 4. Water heating energy requirement

Assumed occupancy, N 1.72 (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 74.96 (43)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 82.45 | 79.45 | 76.45 | 73.46 | 70.46 | 67.46 | 67.46 | 70.46 | 73.46 | 76.45 | 79.45 | 82.45 | |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 122.27 | 106.94 | 110.35 | 96.21 | 92.31 | 79.66 | 73.82 | 84.71 | 85.72 | 99.90 | 109.04 | 118.41 | |
| Distribution loss 0.15 x (45)m | 18.34 | 16.04 | 16.55 | 14.43 | 13.85 | 11.95 | 11.07 | 12.71 | 12.86 | 14.98 | 16.36 | 17.76 | (46) |

∑(44)1...12 = 899.47 (44)

∑(45)1...12 = 1179.35 (45)

Storage volume (litres) including any solar or WWHRS storage within same vessel 3.00 (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day) 0.26 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage (kWh/day) (48) x (49) 0.14 (50)

Enter (50) or (54) in (55) 0.14 (55)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149.89 | 131.89 | 137.97 | 122.94 | 119.93 | 106.39 | 101.43 | 112.32 | 112.44 | 127.51 | 135.77 | 146.03 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149.89 | 131.89 | 137.97 | 122.94 | 119.93 | 106.39 | 101.43 | 112.32 | 112.44 | 127.51 | 135.77 | 146.03 | |

∑(64)1...12 = 1504.52 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62.75 | 55.51 | 58.79 | 53.37 | 52.79 | 47.87 | 46.64 | 50.26 | 49.88 | 55.31 | 57.64 | 61.47 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | | | | | | | | | | | | | |
| | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 14.04 | 12.47 | 10.14 | 7.68 | 5.74 | 4.85 | 5.24 | 6.81 | 9.14 | 11.60 | 13.54 | 14.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 149.52 | 151.07 | 147.16 | 138.84 | 128.33 | 118.46 | 111.86 | 110.31 | 114.22 | 122.54 | 133.05 | 142.92 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | (69) |
| Pump and fan gains (Table 5a) | | | | | | | | | | | | | |
| | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |
| Losses e.g. evaporation (Table 5) | | | | | | | | | | | | | |
| | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 84.34 | 82.61 | 79.01 | 74.13 | 70.95 | 66.48 | 62.69 | 67.55 | 69.28 | 74.34 | 80.05 | 82.62 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | | | | | | | | | | | | | |
| | 299.64 | 297.89 | 288.06 | 272.38 | 256.76 | 241.53 | 231.52 | 236.41 | 244.37 | 260.22 | 278.38 | 291.71 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.77 | x | 4.56 | x | 10.63 | x 0.9 x | 0.63 | x | 0.70 | = | 14.82 | (74) |
| East | 0.77 | x | 3.20 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 19.21 | (76) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34.03 | 65.89 | 110.00 | 167.54 | 214.72 | 224.69 | 211.86 | 175.15 | 129.82 | 78.29 | 42.23 | 28.15 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 333.67 | 363.79 | 398.06 | 439.92 | 471.49 | 466.21 | 443.38 | 411.56 | 374.20 | 338.52 | 320.61 | 319.86 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.99 | 0.95 | 0.84 | 0.65 | 0.49 | 0.54 | 0.81 | 0.97 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.02 | 20.14 | 20.35 | 20.64 | 20.88 | 20.98 | 21.00 | 20.99 | 20.93 | 20.64 | 20.28 | 20.00 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.08 | 20.09 | 20.09 | 20.10 | 20.10 | 20.11 | 20.11 | 20.11 | 20.11 | 20.10 | 20.10 | 20.09 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.93 | 0.80 | 0.57 | 0.39 | 0.44 | 0.74 | 0.95 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.78 | 18.95 | 19.26 | 19.68 | 19.98 | 20.09 | 20.11 | 20.11 | 20.05 | 19.68 | 19.17 | 18.75 | (90) |

Living area fraction Living area ÷ (4) = 0.45 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.34 | 19.49 | 19.76 | 20.12 | 20.39 | 20.50 | 20.51 | 20.51 | 20.45 | 20.12 | 19.68 | 19.32 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.34 | 19.49 | 19.76 | 20.12 | 20.39 | 20.50 | 20.51 | 20.51 | 20.45 | 20.12 | 19.68 | 19.32 | (93) |

## 8. Space heating requirement

Utilisation factor for gains, ηm

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.99 | 0.98 | 0.93 | 0.81 | 0.61 | 0.43 | 0.49 | 0.77 | 0.95 | 0.99 | 1.00 | (94) |

Useful gains, ηmGm, W (94)m x (84)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 331.90 | 360.39 | 389.32 | 410.41 | 383.18 | 283.27 | 191.99 | 200.59 | 287.67 | 322.83 | 317.22 | 318.51 | (95) |

Monthly average external temperature from Table U1

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 764.43 | 739.46 | 670.27 | 560.41 | 432.91 | 290.72 | 192.89 | 202.29 | 314.27 | 474.17 | 629.53 | 760.61 | (97) |

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 321.80 | 254.73 | 209.03 | 108.00 | 37.00 | 0.00 | 0.00 | 0.00 | 0.00 | 112.59 | 224.86 | 328.92 |

∑(98)1...5, 10...12 = 1596.93 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 31.39 (99)

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

**Space heating**

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | | 0.00 | (201) |
| Fraction of space heat from main system(s) | 1 - (201) = | 1.00 | (202) |
| Fraction of space heat from main system 2 | | 0.00 | (202) |
| Fraction of total space heat from main system 1 | (202) x [1- (203)] = | 1.00 | (204) |
| Fraction of total space heat from main system 2 | (202) x (203) = | 0.00 | (205) |
| Efficiency of main system 1 (%) | | 93.50 | (206) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 344.17 | 272.44 | 223.56 | 115.51 | 39.57 | 0.00 | 0.00 | 0.00 | 0.00 | 120.42 | 240.49 | 351.79 |

∑(211)1...5, 10...12 = 1707.95 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 86.80 | 86.54 | 85.92 | 84.47 | 82.09 | 79.80 | 79.80 | 79.80 | 79.80 | 84.48 | 86.15 | 86.92 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.68 | 152.40 | 160.58 | 145.54 | 146.10 | 133.32 | 127.11 | 140.76 | 140.91 | 150.93 | 157.60 | 168.01 |

∑(219a)1...12 = 1795.93 (219)

**Annual totals**

Space heating fuel - main system 1 1707.95

| | | | | |
|---|---|---|---|---|
| Water heating fuel | | | 1795.93 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | | (230c) |
| boiler flue fan | 45.00 | | | (230e) |
| Total electricity for the above, kWh/year | | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | | 247.99 | (232) |
| Total delivered energy for all uses | | (211)...(221) + (231) + (232)...(237b) = | 3826.87 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 1707.95 | x | 3.48 | x 0.01 = | 59.44 | (240) |
| Water heating | 1795.93 | x | 3.48 | x 0.01 = | 62.50 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 247.99 | x | 13.19 | x 0.01 = | 32.71 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 284.54 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.25 | (257) |
| SAP value | 82.61 | |
| SAP rating (section 13) | 83 | (258) |
| SAP band | B | |

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

| | Energy kWh/year | | Emission factor kg $CO_2$/kWh | | Emissions kg $CO_2$/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 1707.95 | x | 0.216 | = | 368.92 | (261) |
| Water heating | 1795.93 | x | 0.216 | = | 387.92 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 756.84 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 247.99 | x | 0.519 | = | 128.71 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 924.47 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 18.17 | (273) |
| EI value | | | | | 87.08 | |
| EI rating (section 14) | | | | | 87 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 1707.95 | x | 1.22 | = | 2083.70 | (261) |
| Water heating | 1795.93 | x | 1.22 | = | 2191.04 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 4274.74 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 247.99 | x | 3.07 | = | 761.32 | (268) |
| Primary energy kWh/year | | | | | 5266.31 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 103.50 | (273) |

# TER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 1B2P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 50.32 | (1a) | x | 2.50 | (2a) | = | 125.80 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 50.32 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 125.80 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 2 | x 10 = | 20 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) = | 20 | ÷ (5) = | 0.16 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.41 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.35 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.44 | 0.43 | 0.43 | 0.38 | 0.37 | 0.33 | 0.33 | 0.32 | 0.35 | 0.37 | 0.39 | 0.41 | (22b) |

Calculate effective air change rate for the applicable case:

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.60 | 0.59 | 0.59 | 0.57 | 0.57 | 0.55 | 0.55 | 0.55 | 0.56 | 0.57 | 0.58 | 0.58 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.60 | 0.59 | 0.59 | 0.57 | 0.57 | 0.55 | 0.55 | 0.55 | 0.56 | 0.57 | 0.58 | 0.58 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, $m^2$ | Openings $m^2$ | Net area A, $m^2$ | | U-value W/$m^2$K | | A x U W/K | κ-value, kJ/$m^2$.K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 7.86 | x | 1.33 | = | 10.42 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| External wall | | | 30.82 | x | 0.18 | = | 5.55 | | | (29a) |
| Party wall | | | 34.43 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 50.32 | x | 0.13 | = | 6.54 | | | (30) |
| Total area of external elements ∑A, $m^2$ | | | 90.80 | | | | | | | (31) |

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 24.31 (33)

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

Thermal mass parameter (TMP) in kJ/$m^2$K 250.00 (35)

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 9.32 (36)

Total fabric heat loss (33) + (36) = 33.62 (37)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24.83 | 24.68 | 24.52 | 23.79 | 23.66 | 23.02 | 23.02 | 22.90 | 23.27 | 23.66 | 23.93 | 24.22 | (38) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 58.46 | 58.30 | 58.15 | 57.42 | 57.28 | 56.65 | 56.65 | 56.53 | 56.89 | 57.28 | 57.56 | 57.85 |

Average = ∑(39)1...12/12 = 57.42 (39)

Heat loss parameter (HLP), W/$m^2$K (39)m ÷ (4)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.16 | 1.16 | 1.16 | 1.14 | 1.14 | 1.13 | 1.13 | 1.12 | 1.13 | 1.14 | 1.14 | 1.15 |

Average = ∑(40)1...12/12 = 1.14 (40)

Number of days in month (Table 1a)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

Assumed occupancy, N 1.70 (42)

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

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 82.02 | 79.04 | 76.06 | 73.07 | 70.09 | 67.11 | 67.11 | 70.09 | 73.07 | 76.06 | 79.04 | 82.02 |

∑(44)1...12 = 894.76 (44)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 121.63 | 106.38 | 109.78 | 95.71 | 91.83 | 79.24 | 73.43 | 84.26 | 85.27 | 99.37 | 108.47 | 117.80 |

∑(45)1...12 = 1173.18 (45)

Distribution loss 0.15 x (45)m

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.25 | 15.96 | 16.47 | 14.36 | 13.77 | 11.89 | 11.01 | 12.64 | 12.79 | 14.91 | 16.27 | 17.67 | (46) |

Storage volume (litres) including any solar or WWHRS storage within same vessel 3.00 (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day) 0.26 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage (kWh/day) (48) x (49) 0.14 (50)

Enter (50) or (54) in (55) 0.14 (55)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149.25 | 131.33 | 137.39 | 122.43 | 119.45 | 105.97 | 101.05 | 111.88 | 112.00 | 126.99 | 135.20 | 145.41 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 149.25 | 131.33 | 137.39 | 122.43 | 119.45 | 105.97 | 101.05 | 111.88 | 112.00 | 126.99 | 135.20 | 145.41 |

∑(64)1...12 = 1498.35 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62.54 | 55.33 | 58.59 | 53.20 | 52.63 | 47.73 | 46.51 | 50.11 | 49.73 | 55.14 | 57.45 | 61.26 | (65) |

## 5. Internal gains

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

Metabolic gains (Table 5)

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 13.84 | 12.29 | 10.00 | 7.57 | 5.66 | 4.78 | 5.16 | 6.71 | 9.00 | 11.43 | 13.34 | 14.22 | (67) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 148.07 | 149.60 | 145.73 | 137.49 | 127.08 | 117.30 | 110.77 | 109.23 | 113.11 | 121.35 | 131.75 | 141.53 | (68) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | (69) |

Pump and fan gains (Table 5a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |

Losses e.g. evaporation (Table 5)

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

Water heating gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 84.06 | 82.33 | 78.76 | 73.89 | 70.74 | 66.29 | 62.51 | 67.35 | 69.07 | 74.11 | 79.79 | 82.34 | (72) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 297.45 | 295.72 | 285.97 | 270.44 | 254.97 | 239.86 | 229.94 | 234.79 | 242.68 | 258.38 | 276.38 | 289.59 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.77 | x | 7.86 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 47.18 | (80) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 47.18 | 92.29 | 151.99 | 221.67 | 271.66 | 278.09 | 264.76 | 227.42 | 176.77 | 109.51 | 58.83 | 38.80 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 344.63 | 388.01 | 437.96 | 492.11 | 526.63 | 517.96 | 494.69 | 462.21 | 419.45 | 367.89 | 335.20 | 328.38 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.94 | 0.84 | 0.66 | 0.50 | 0.55 | 0.81 | 0.96 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 19.82 | 19.97 | 20.23 | 20.57 | 20.83 | 20.96 | 20.99 | 20.99 | 20.90 | 20.55 | 20.13 | 19.80 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C) | | | | | | | | | | | | | |
| | 19.95 | 19.95 | 19.96 | 19.97 | 19.97 | 19.98 | 19.98 | 19.98 | 19.98 | 19.97 | 19.97 | 19.96 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | | | | | | | | | | | | | |
| | 1.00 | 0.99 | 0.98 | 0.92 | 0.79 | 0.57 | 0.39 | 0.43 | 0.73 | 0.95 | 0.99 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | | | | | | | | | | | | | |
| | 18.39 | 18.61 | 18.99 | 19.47 | 19.81 | 19.96 | 19.98 | 19.98 | 19.90 | 19.46 | 18.85 | 18.36 | (90) |

Living area fraction Living area ÷ (4) = 0.55 (91)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | | | | | | | | | | | | | |
| | 19.17 | 19.35 | 19.66 | 20.07 | 20.37 | 20.51 | 20.53 | 20.53 | 20.44 | 20.05 | 19.54 | 19.14 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | | | | | | | | | | | | | |
| | 19.17 | 19.35 | 19.66 | 20.07 | 20.37 | 20.51 | 20.53 | 20.53 | 20.44 | 20.05 | 19.54 | 19.14 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | | | | | | | | | | | | | |
| | 0.99 | 0.99 | 0.97 | 0.92 | 0.81 | 0.62 | 0.45 | 0.50 | 0.77 | 0.95 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | | |
| | 342.56 | 383.61 | 426.10 | 454.54 | 426.33 | 320.89 | 220.60 | 229.84 | 321.86 | 349.48 | 331.30 | 326.81 | (95) |
| Monthly average external temperature from Table U1 | | | | | | | | | | | | | |
| | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | | | | | | | | | | | | | |
| | 869.34 | 842.43 | 765.43 | 641.24 | 496.41 | 334.50 | 222.68 | 233.39 | 360.89 | 541.42 | 716.29 | 864.49 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | | | | | | | | | | | | | |
| | 391.93 | 308.32 | 252.46 | 134.42 | 52.14 | 0.00 | 0.00 | 0.00 | 0.00 | 142.80 | 277.19 | 400.04 | |

∑(98)1...5, 10...12 = 1959.30 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 38.94 (99)

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

**Space heating**

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | | 0.00 | (201) |
| Fraction of space heat from main system(s) | 1 - (201) = | 1.00 | (202) |
| Fraction of space heat from main system 2 | | 0.00 | (202) |
| Fraction of total space heat from main system 1 | (202) x [1- (203)] = | 1.00 | (204) |
| Fraction of total space heat from main system 2 | (202) x (203) = | 0.00 | (205) |
| Efficiency of main system 1 (%) | | 93.50 | (206) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating fuel (main system 1), kWh/month | | | | | | | | | | | | | |
| | 419.17 | 329.76 | 270.01 | 143.77 | 55.76 | 0.00 | 0.00 | 0.00 | 0.00 | 152.73 | 296.46 | 427.85 | |

∑(211)1...5, 10...12 = 2095.50 (211)

**Water heating**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Efficiency of water heater | | | | | | | | | | | | | |
| | 87.27 | 87.01 | 86.42 | 85.06 | 82.77 | 79.80 | 79.80 | 79.80 | 79.80 | 85.13 | 86.69 | 87.38 | (217) |
| Water heating fuel, kWh/month | | | | | | | | | | | | | |
| | 171.02 | 150.92 | 158.99 | 143.93 | 144.31 | 132.80 | 126.63 | 140.20 | 140.35 | 149.18 | 155.96 | 166.42 | |

∑(219a)1...12 = 1780.70 (219)

**Annual totals**

Space heating fuel - main system 1 2095.50

| | | | | |
|---|---|---|---|---|
| Water heating fuel | | | 1780.70 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | | (230c) |
| boiler flue fan | 45.00 | | | (230e) |
| Total electricity for the above, kWh/year | | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | | 244.38 | (232) |
| Total delivered energy for all uses | | (211)...(221) + (231) + (232)...(237b) = | 4195.58 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2095.50 | x | 3.48 | x 0.01 = | 72.92 | (240) |
| Water heating | 1780.70 | x | 3.48 | x 0.01 = | 61.97 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 244.38 | x | 13.19 | x 0.01 = | 32.23 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 297.02 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.31 | (257) |
| SAP value | 81.74 | |
| SAP rating (section 13) | 82 | (258) |
| SAP band | B | |

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

| | Energy kWh/year | | Emission factor kg $CO_2$/kWh | | Emissions kg $CO_2$/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2095.50 | x | 0.216 | = | 452.63 | (261) |
| Water heating | 1780.70 | x | 0.216 | = | 384.63 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 837.26 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 244.38 | x | 0.519 | = | 126.83 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1003.02 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 19.93 | (273) |
| EI value | | | | | 85.90 | |
| EI rating (section 14) | | | | | 86 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2095.50 | x | 1.22 | = | 2556.52 | (261) |
| Water heating | 1780.70 | x | 1.22 | = | 2172.45 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 4728.97 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 244.38 | x | 3.07 | = | 750.24 | (268) |
| Primary energy kWh/year | | | | | 5709.46 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 113.46 | (273) |

# TER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 2B3P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 64.62 | (1a) | x | 2.50 | (2a) | = | 161.55 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 64.62 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 161.55 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 2 | x 10 = | 20 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

| | | | | Air changes per hour | |
|---|---|---|---|---|---|
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 20 | ÷ (5) = | 0.12 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.37 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.32 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.41 | 0.40 | 0.39 | 0.35 | 0.34 | 0.30 | 0.30 | 0.29 | 0.32 | 0.34 | 0.36 | 0.37 | (22b) |

Calculate effective air change rate for the applicable case:

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.58 | 0.58 | 0.58 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.58 | 0.58 | 0.58 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, $m^2$ | Openings $m^2$ | Net area A, $m^2$ | | U-value $W/m^2K$ | | A x U W/K | κ-value, $kJ/m^2.K$ | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 14.37 | x | 1.33 | = | 19.05 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| External wall | | | 54.23 | x | 0.18 | = | 9.76 | | | (29a) |
| Party wall | | | 14.88 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 64.62 | x | 0.13 | = | 8.40 | | | (30) |
| Total area of external elements ∑A, $m^2$ | | | 135.02 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 39.01 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in $kJ/m^2K$ | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 17.71 | (36) |
| Total fabric heat loss | (33) + (36) = | 56.72 | (37) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.03 | 30.86 | 30.69 | 29.91 | 29.77 | 29.08 | 29.08 | 28.96 | 29.35 | 29.77 | 30.06 | 30.37 | (38) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.76 | 87.59 | 87.42 | 86.64 | 86.49 | 85.81 | 85.81 | 85.68 | 86.07 | 86.49 | 86.79 | 87.10 |

Average = ∑(39)1...12/12 = 86.64 (39)

Heat loss parameter (HLP), $W/m^2K$ (39)m ÷ (4)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.36 | 1.36 | 1.35 | 1.34 | 1.34 | 1.33 | 1.33 | 1.33 | 1.33 | 1.34 | 1.34 | 1.35 |

Average = ∑(40)1...12/12 = 1.34 (40)

Number of days in month (Table 1a)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.11 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 84.28 | (43) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 92.71 | 89.34 | 85.97 | 82.60 | 79.23 | 75.86 | 75.86 | 79.23 | 82.60 | 85.97 | 89.34 | 92.71 |

∑(44)1...12 = 1011.41 (44)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 137.49 | 120.25 | 124.09 | 108.18 | 103.80 | 89.57 | 83.00 | 95.25 | 96.39 | 112.33 | 122.61 | 133.15 |

∑(45)1...12 = 1326.12 (45)

Distribution loss 0.15 x (45)m

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.62 | 18.04 | 18.61 | 16.23 | 15.57 | 13.44 | 12.45 | 14.29 | 14.46 | 16.85 | 18.39 | 19.97 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.26 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.14 | (50) |
| Enter (50) or (54) in (55) | 0.14 | (55) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Primary circuit loss for each month from Table 3 | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |
| Combi loss for each month from Table 3a, 3b or 3c | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (61) |
| Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m | 165.11 | 145.19 | 151.70 | 134.91 | 131.42 | 116.30 | 110.62 | 122.87 | 123.11 | 139.95 | 149.34 | 160.77 | (62) |
| Solar DHW input calculated using Appendix G or Appendix H | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (63) |
| Output from water heater for each month (kWh/month) (62)m + (63)m | 165.11 | 145.19 | 151.70 | 134.91 | 131.42 | 116.30 | 110.62 | 122.87 | 123.11 | 139.95 | 149.34 | 160.77 | |
| | | | | | | | | | | | ∑(64)1...12 = | 1651.29 | (64) |
| Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m] | 67.81 | 59.94 | 63.35 | 57.35 | 56.61 | 51.16 | 49.69 | 53.76 | 53.43 | 59.44 | 62.15 | 66.37 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 16.44 | 14.60 | 11.88 | 8.99 | 6.72 | 5.67 | 6.13 | 7.97 | 10.70 | 13.58 | 15.85 | 16.90 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 184.43 | 186.34 | 181.52 | 171.25 | 158.29 | 146.11 | 137.98 | 136.06 | 140.88 | 151.15 | 164.11 | 176.29 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | (69) |
| Pump and fan gains (Table 5a) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |
| Losses e.g. evaporation (Table 5) | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | (71) |
| Water heating gains (Table 5) | 91.14 | 89.19 | 85.15 | 79.66 | 76.09 | 71.06 | 66.79 | 72.26 | 74.21 | 79.90 | 86.32 | 89.20 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 349.65 | 347.78 | 336.18 | 317.53 | 298.73 | 280.48 | 268.53 | 273.93 | 283.42 | 302.26 | 323.92 | 340.03 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.77 | x | 7.83 | x | 10.63 | x 0.9 x | 0.63 | x | 0.70 | = | 25.45 | (74) |
| East | 0.77 | x | 6.54 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 39.26 | (76) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | 64.70 | 125.42 | 209.09 | 317.16 | 404.83 | 422.79 | 398.99 | 331.00 | 246.43 | 149.00 | 80.34 | 53.49 | (83) |
| Total gains - internal and solar (73)m + (83)m | 414.35 | 473.19 | 545.28 | 634.70 | 703.57 | 703.27 | 667.52 | 604.93 | 529.85 | 451.27 | 404.25 | 393.52 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 0.99 | 0.99 | 0.95 | 0.87 | 0.70 | 0.55 | 0.61 | 0.86 | 0.98 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.53 | 19.68 | 19.98 | 20.38 | 20.73 | 20.92 | 20.98 | 20.97 | 20.81 | 20.36 | 19.87 | 19.50 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.80 | 19.80 | 19.80 | 19.81 | 19.81 | 19.82 | 19.82 | 19.82 | 19.82 | 19.81 | 19.81 | 19.80 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.94 | 0.82 | 0.60 | 0.41 | 0.47 | 0.79 | 0.96 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17.85 | 18.08 | 18.51 | 19.09 | 19.55 | 19.77 | 19.81 | 19.81 | 19.66 | 19.07 | 18.36 | 17.82 | (90) |

Living area fraction — Living area ÷ (4) = 0.42 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.55 | 18.75 | 19.12 | 19.63 | 20.04 | 20.25 | 20.30 | 20.29 | 20.14 | 19.60 | 18.99 | 18.52 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.55 | 18.75 | 19.12 | 19.63 | 20.04 | 20.25 | 20.30 | 20.29 | 20.14 | 19.60 | 18.99 | 18.52 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.99 | 0.98 | 0.93 | 0.83 | 0.64 | 0.47 | 0.53 | 0.81 | 0.96 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 412.22 | 468.65 | 532.79 | 592.59 | 581.71 | 452.29 | 311.41 | 322.74 | 428.84 | 433.71 | 400.42 | 391.90 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1250.55 | 1213.11 | 1103.38 | 929.26 | 721.26 | 484.95 | 317.45 | 333.46 | 519.66 | 778.71 | 1032.08 | 1247.01 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 623.72 | 500.28 | 424.52 | 242.40 | 103.82 | 0.00 | 0.00 | 0.00 | 0.00 | 256.68 | 454.79 | 636.20 | |

∑(98)1...5, 10...12 = 3242.41 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 50.18 (99)

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

**Space heating**

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | | 0.00 | (201) |
| Fraction of space heat from main system(s) | 1 - (201) = | 1.00 | (202) |
| Fraction of space heat from main system 2 | | 0.00 | (202) |
| Fraction of total space heat from main system 1 | (202) x [1- (203)] = | 1.00 | (204) |
| Fraction of total space heat from main system 2 | (202) x (203) = | 0.00 | (205) |
| Efficiency of main system 1 (%) | | 93.50 | (206) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating fuel (main system 1), kWh/month | 667.08 | 535.06 | 454.04 | 259.25 | 111.04 | 0.00 | 0.00 | 0.00 | 0.00 | 274.52 | 486.41 | 680.43 | |

∑(211)1...5, 10...12 = 3467.81 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88.03 | 87.85 | 87.41 | 86.36 | 84.19 | 79.80 | 79.80 | 79.80 | 79.80 | 86.41 | 87.60 | 88.12 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 187.56 | 165.28 | 173.55 | 156.22 | 156.09 | 145.74 | 138.62 | 153.97 | 154.28 | 161.95 | 170.49 | 182.45 |

∑(219a)1...12 = 1946.19 (219)

**Annual totals**

| | | | |
|---|---|---|---|
| Space heating fuel - main system 1 | | 3467.81 | |
| Water heating fuel | | 1946.19 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | (230c) |
| boiler flue fan | 45.00 | | (230e) |
| Total electricity for the above, kWh/year | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | 290.39 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 5779.39 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3467.81 | x | 3.48 | x 0.01 = | 120.68 | (240) |
| Water heating | 1946.19 | x | 3.48 | x 0.01 = | 67.73 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 290.39 | x | 13.19 | x 0.01 = | 38.30 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 356.60 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.37 | (257) |
| SAP value | 80.94 | |
| SAP rating (section 13) | 81 | (258) |
| SAP band | B | |

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

| | Energy kWh/year | | Emission factor kg $CO_2$/kWh | | Emissions kg $CO_2$/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3467.81 | x | 0.216 | = | 749.05 | (261) |
| Water heating | 1946.19 | x | 0.216 | = | 420.38 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 1169.42 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 290.39 | x | 0.519 | = | 150.71 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1359.06 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 21.03 | (273) |
| EI value | | | | | 83.39 | |
| EI rating (section 14) | | | | | 83 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3467.81 | x | 1.22 | = | 4230.73 | (261) |
| Water heating | 1946.19 | x | 1.22 | = | 2374.35 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 6605.09 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 290.39 | x | 3.07 | = | 891.49 | (268) |
| Primary energy kWh/year | | | | | 7726.83 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 119.57 | (273) |

# TER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco  Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 2B4P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 73.74 | (1a) | x | 2.50 | (2a) | = | 184.35 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 73.74 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 184.35 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 3 | x 10 = | 30 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

| | | | | Air changes per hour | |
|---|---|---|---|---|---|
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 30 | ÷ (5) = | 0.16 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.41 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.35 | (21) |

Infiltration rate modified for monthly wind speed:

Monthly average wind speed from Table U2

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |

Wind factor (22)m ÷ 4

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.45 | 0.44 | 0.43 | 0.39 | 0.38 | 0.33 | 0.33 | 0.32 | 0.35 | 0.38 | 0.39 | 0.41 | (22b) |

Calculate effective air change rate for the applicable case:

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.60 | 0.60 | 0.59 | 0.57 | 0.57 | 0.56 | 0.56 | 0.55 | 0.56 | 0.57 | 0.58 | 0.58 | (24d) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.60 | 0.60 | 0.59 | 0.57 | 0.57 | 0.56 | 0.56 | 0.55 | 0.56 | 0.57 | 0.58 | 0.58 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 15.42 | x | 1.33 | = | 20.44 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| External wall | | | 59.21 | x | 0.18 | = | 10.66 | | | (29a) |
| Party wall | | | 15.83 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 76.43 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 32.90 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 6.52 | (36) |
| Total fabric heat loss | (33) + (36) = | 39.42 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 36.50 | 36.27 | 36.04 | 34.95 | 34.74 | 33.80 | 33.80 | 33.62 | 34.16 | 34.74 | 35.16 | 35.59 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 75.92 | 75.69 | 75.45 | 74.37 | 74.16 | 73.22 | 73.22 | 73.04 | 73.58 | 74.16 | 74.57 | 75.01 | |

Average = ∑(39)1...12/12 = 74.37 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.03 | 1.03 | 1.02 | 1.01 | 1.01 | 0.99 | 0.99 | 0.99 | 1.00 | 1.01 | 1.01 | 1.02 | |

Average = ∑(40)1...12/12 = 1.01 (40)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.33 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.62 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 98.58 | 95.00 | 91.41 | 87.83 | 84.24 | 80.66 | 80.66 | 84.24 | 87.83 | 91.41 | 95.00 | 98.58 | |

∑(44)1...12 = 1075.42 (44)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.19 | 127.86 | 131.94 | 115.03 | 110.37 | 95.24 | 88.26 | 101.28 | 102.49 | 119.44 | 130.37 | 141.58 | |

∑(45)1...12 = 1410.04 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 21.93 | 19.18 | 19.79 | 17.25 | 16.56 | 14.29 | 13.24 | 15.19 | 15.37 | 17.92 | 19.56 | 21.24 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.26 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.14 | (50) |
| Enter (50) or (54) in (55) | 0.14 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.81 | 152.80 | 159.56 | 141.76 | 137.99 | 121.97 | 115.87 | 128.89 | 129.21 | 147.05 | 157.10 | 169.20 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.81 | 152.80 | 159.56 | 141.76 | 137.99 | 121.97 | 115.87 | 128.89 | 129.21 | 147.05 | 157.10 | 169.20 | |

∑(64)1...12 = 1735.22 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.70 | 62.47 | 65.96 | 59.63 | 58.79 | 53.05 | 51.44 | 55.77 | 55.46 | 61.81 | 64.73 | 69.17 | (65) |

## 5. Internal gains

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

Metabolic gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | (66) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.41 | 16.35 | 13.30 | 10.07 | 7.53 | 6.35 | 6.86 | 8.92 | 11.98 | 15.21 | 17.75 | 18.92 | (67) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 205.86 | 208.00 | 202.62 | 191.16 | 176.69 | 163.09 | 154.01 | 151.87 | 157.26 | 168.72 | 183.18 | 196.78 | (68) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | (69) |

Pump and fan gains (Table 5a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |

Losses e.g. evaporation (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95.03 | 92.96 | 88.66 | 82.82 | 79.02 | 73.68 | 69.14 | 74.96 | 77.02 | 83.07 | 89.90 | 92.97 | (72) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 380.30 | 378.31 | 365.58 | 345.04 | 324.24 | 304.13 | 291.02 | 296.76 | 307.26 | 328.00 | 351.84 | 369.67 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.77 | x | 10.90 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 65.43 | (76) |
| South | 0.77 | x | 2.22 | x | 46.75 | x 0.9 x | 0.63 | x | 0.70 | = | 31.72 | (78) |
| West | 0.77 | x | 2.30 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 13.81 | (80) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 110.95 | 206.94 | 321.42 | 447.06 | 534.16 | 542.03 | 517.91 | 453.10 | 365.99 | 239.94 | 136.39 | 92.56 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 491.25 | 585.25 | 687.00 | 792.10 | 858.40 | 846.16 | 808.93 | 749.85 | 673.25 | 567.94 | 488.23 | 462.24 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.97 | 0.90 | 0.74 | 0.54 | 0.40 | 0.45 | 0.71 | 0.95 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.99 | 20.17 | 20.44 | 20.75 | 20.93 | 20.99 | 21.00 | 21.00 | 20.96 | 20.69 | 20.28 | 19.96 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.06 | 20.06 | 20.06 | 20.08 | 20.08 | 20.09 | 20.09 | 20.09 | 20.09 | 20.08 | 20.07 | 20.07 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.96 | 0.87 | 0.69 | 0.47 | 0.32 | 0.36 | 0.63 | 0.92 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.71 | 18.97 | 19.37 | 19.80 | 20.02 | 20.08 | 20.09 | 20.09 | 20.06 | 19.74 | 19.15 | 18.67 | (90) |

Living area fraction Living area ÷ (4) = 0.41 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.23 | 19.46 | 19.81 | 20.19 | 20.39 | 20.45 | 20.46 | 20.46 | 20.42 | 20.13 | 19.61 | 19.20 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.23 | 19.46 | 19.81 | 20.19 | 20.39 | 20.45 | 20.46 | 20.46 | 20.42 | 20.13 | 19.61 | 19.20 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.99 | 0.96 | 0.87 | 0.71 | 0.50 | 0.35 | 0.39 | 0.66 | 0.92 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 488.43 | 576.72 | 657.89 | 690.53 | 606.51 | 423.95 | 282.07 | 295.57 | 445.78 | 525.00 | 481.85 | 460.28 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1133.47 | 1102.02 | 1004.03 | 839.47 | 644.45 | 428.48 | 282.54 | 296.50 | 465.37 | 706.46 | 932.71 | 1124.82 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 479.91 | 353.00 | 257.53 | 107.23 | 28.23 | 0.00 | 0.00 | 0.00 | 0.00 | 135.01 | 324.62 | 494.42 | |

∑(98)1...5, 10...12 = 2179.95 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 29.56 (99)

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

**Space heating**

Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201)

Fraction of space heat from main system(s) 1 - (201) = 1.00 (202)

Fraction of space heat from main system 2 0.00 (202)

Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204)

Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205)

Efficiency of main system 1 (%) 93.50 (206)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating fuel (main system 1), kWh/month | 513.27 | 377.54 | 275.44 | 114.69 | 30.19 | 0.00 | 0.00 | 0.00 | 0.00 | 144.39 | 347.19 | 528.79 | |

∑(211)1...5, 10...12 = 2331.50 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.38 | 86.98 | 86.08 | 84.08 | 81.44 | 79.80 | 79.80 | 79.80 | 79.80 | 84.59 | 86.71 | 87.51 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 198.90 | 175.68 | 185.35 | 168.59 | 169.45 | 152.84 | 145.21 | 161.52 | 161.92 | 173.85 | 181.18 | 193.35 |

∑(219a)1...12 = 2067.85 (219)

**Annual totals**

| | | | | |
|---|---|---|---|---|
| Space heating fuel - main system 1 | | | 2331.50 | |
| Water heating fuel | | | 2067.85 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | | (230c) |
| boiler flue fan | 45.00 | | | (230e) |
| Total electricity for the above, kWh/year | | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | | 325.11 | (232) |
| Total delivered energy for all uses | | (211)...(221) + (231) + (232)...(237b) = | 4799.45 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2331.50 | x | 3.48 | x 0.01 = | 81.14 | (240) |
| Water heating | 2067.85 | x | 3.48 | x 0.01 = | 71.96 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 325.11 | x | 13.19 | x 0.01 = | 42.88 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 325.87 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.15 | (257) |
| SAP value | 83.92 | |
| SAP rating (section 13) | 84 | (258) |
| SAP band | B | |

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

| | Energy kWh/year | | Emission factor kg $CO_2$/kWh | | Emissions kg $CO_2$/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2331.50 | x | 0.216 | = | 503.60 | (261) |
| Water heating | 2067.85 | x | 0.216 | = | 446.66 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 950.26 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 325.11 | x | 0.519 | = | 168.73 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1157.91 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 15.70 | (273) |
| EI value | | | | | 86.93 | |
| EI rating (section 14) | | | | | 87 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2331.50 | x | 1.22 | = | 2844.43 | (261) |
| Water heating | 2067.85 | x | 1.22 | = | 2522.78 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 5367.20 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 325.11 | x | 3.07 | = | 998.08 | (268) |
| Primary energy kWh/year | | | | | 6595.53 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 89.44 | (273) |

# TER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 2B3P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.00 | (1a) | x | 2.50 | (2a) | = | 185.00 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.00 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 185.00 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 3 | x 10 = | 30 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

| | | | | Air changes per hour | |
|---|---|---|---|---|---|
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 30 | ÷ (5) = | 0.16 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.41 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.35 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.45 | 0.44 | 0.43 | 0.39 | 0.38 | 0.33 | 0.33 | 0.32 | 0.35 | 0.38 | 0.39 | 0.41 | (22b) |

Calculate effective air change rate for the applicable case:

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.60 | 0.60 | 0.59 | 0.57 | 0.57 | 0.56 | 0.56 | 0.55 | 0.56 | 0.57 | 0.58 | 0.58 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.60 | 0.60 | 0.59 | 0.57 | 0.57 | 0.56 | 0.56 | 0.55 | 0.56 | 0.57 | 0.58 | 0.58 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 16.71 | x | 1.33 | = | 22.15 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| External wall | | | 34.34 | x | 0.18 | = | 6.18 | | | (29a) |
| Party wall | | | 32.15 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 52.85 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 30.13 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 6.08 | (36) |
| Total fabric heat loss | (33) + (36) = | 36.21 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 36.62 | 36.38 | 36.15 | 35.06 | 34.85 | 33.91 | 33.91 | 33.73 | 34.27 | 34.85 | 35.27 | 35.70 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 72.83 | 72.59 | 72.36 | 71.27 | 71.07 | 70.12 | 70.12 | 69.94 | 70.48 | 71.07 | 71.48 | 71.91 | |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.98 | 0.98 | 0.98 | 0.96 | 0.96 | 0.95 | 0.95 | 0.95 | 0.95 | 0.96 | 0.97 | 0.97 | |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

Average = ∑(39)1...12/12 = 71.27 (39)

Average = ∑(40)1...12/12 = 0.96 (40)

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.34 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.76 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 98.73 | 95.14 | 91.55 | 87.96 | 84.37 | 80.78 | 80.78 | 84.37 | 87.96 | 91.55 | 95.14 | 98.73 | |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.42 | 128.06 | 132.14 | 115.21 | 110.54 | 95.39 | 88.39 | 101.43 | 102.64 | 119.62 | 130.57 | 141.80 | |
| Distribution loss 0.15 x (45)m | 21.96 | 19.21 | 19.82 | 17.28 | 16.58 | 14.31 | 13.26 | 15.21 | 15.40 | 17.94 | 19.59 | 21.27 | (46) |

∑(44)1...12 = 1077.07 (44)

∑(45)1...12 = 1412.21 (45)

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.26 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.14 | (50) |
| Enter (50) or (54) in (55) | 0.14 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 174.03 | 153.00 | 159.76 | 141.93 | 138.16 | 122.12 | 116.01 | 129.05 | 129.37 | 147.24 | 157.30 | 169.41 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 174.03 | 153.00 | 159.76 | 141.93 | 138.16 | 122.12 | 116.01 | 129.05 | 129.37 | 147.24 | 157.30 | 169.41 | |

∑(64)1...12 = 1737.39 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.78 | 62.53 | 66.03 | 59.69 | 58.85 | 53.10 | 51.48 | 55.82 | 55.51 | 61.87 | 64.80 | 69.24 | (65) |

## 5. Internal gains

Metabolic gains (Table 5)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | (66) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.40 | 16.34 | 13.29 | 10.06 | 7.52 | 6.35 | 6.86 | 8.92 | 11.97 | 15.20 | 17.74 | 18.91 | (67) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 206.45 | 208.59 | 203.19 | 191.70 | 177.19 | 163.56 | 154.45 | 152.30 | 157.70 | 169.20 | 183.70 | 197.34 | (68) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | (69) |

Pump and fan gains (Table 5a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |

Losses e.g. evaporation (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 95.13 | 93.06 | 88.75 | 82.90 | 79.10 | 73.75 | 69.20 | 75.03 | 77.10 | 83.16 | 90.00 | 93.07 | (72) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 381.07 | 379.08 | 366.32 | 345.75 | 324.90 | 304.74 | 291.60 | 297.34 | 307.86 | 328.64 | 352.53 | 370.41 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.77 | x | 5.67 | x | 10.63 | x 0.9 x | 0.63 | x | 0.70 | = | 18.43 | (74) |
| NorthEast | 0.77 | x | 2.98 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 10.28 | (75) |
| West | 0.77 | x | 8.06 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 48.38 | (80) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 77.08 | 150.77 | 253.38 | 385.31 | 491.24 | 512.46 | 483.86 | 402.02 | 299.13 | 179.77 | 95.98 | 63.54 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 458.15 | 529.85 | 619.70 | 731.06 | 816.13 | 817.20 | 775.46 | 699.36 | 606.99 | 508.42 | 448.51 | 433.94 | (84) |

## 7. Mean internal temperature (heating season)

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

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.91 | 0.75 | 0.54 | 0.40 | 0.46 | 0.75 | 0.96 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.01 | 20.16 | 20.42 | 20.74 | 20.94 | 20.99 | 21.00 | 21.00 | 20.96 | 20.67 | 20.28 | 19.98 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.10 | 20.10 | 20.10 | 20.11 | 20.12 | 20.13 | 20.13 | 20.13 | 20.12 | 20.12 | 20.11 | 20.11 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.97 | 0.89 | 0.70 | 0.47 | 0.32 | 0.37 | 0.67 | 0.94 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.77 | 18.99 | 19.37 | 19.83 | 20.06 | 20.12 | 20.13 | 20.13 | 20.09 | 19.74 | 19.18 | 18.74 | (90) |

Living area fraction Living area ÷ (4) = 0.48 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.37 | 19.56 | 19.88 | 20.27 | 20.48 | 20.54 | 20.55 | 20.55 | 20.51 | 20.19 | 19.71 | 19.34 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.37 | 19.56 | 19.88 | 20.27 | 20.48 | 20.54 | 20.55 | 20.55 | 20.51 | 20.19 | 19.71 | 19.34 | (93) |

## 8. Space heating requirement

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

Utilisation factor for gains, ηm

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.97 | 0.89 | 0.72 | 0.51 | 0.36 | 0.41 | 0.71 | 0.95 | 0.99 | 1.00 | (94) |

Useful gains, ηmGm, W (94)m x (84)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 456.31 | 524.87 | 601.52 | 652.99 | 587.50 | 412.81 | 276.47 | 289.24 | 428.16 | 481.28 | 444.53 | 432.64 | (95) |

Monthly average external temperature from Table U1

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1097.28 | 1063.94 | 968.05 | 810.37 | 624.23 | 416.73 | 276.89 | 290.19 | 451.72 | 681.55 | 901.51 | 1088.88 | (97) |

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 476.88 | 362.25 | 272.69 | 113.31 | 27.33 | 0.00 | 0.00 | 0.00 | 0.00 | 149.00 | 329.03 | 488.24 |

∑(98)1...5, 10...12 = 2218.74 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 29.98 (99)

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

**Space heating**

Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201)

Fraction of space heat from main system(s) 1 - (201) = 1.00 (202)

Fraction of space heat from main system 2 0.00 (202)

Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204)

Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205)

Efficiency of main system 1 (%) 93.50 (206)

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 510.03 | 387.44 | 291.65 | 121.19 | 29.23 | 0.00 | 0.00 | 0.00 | 0.00 | 159.36 | 351.90 | 522.19 |

∑(211)1...5, 10...12 = 2372.99 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.37 | 87.03 | 86.23 | 84.22 | 81.39 | 79.80 | 79.80 | 79.80 | 79.80 | 84.85 | 86.74 | 87.48 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 199.20 | 175.79 | 185.28 | 168.52 | 169.75 | 153.03 | 145.38 | 161.72 | 162.12 | 173.54 | 181.35 | 193.66 |

∑(219a)1...12 = 2069.33 (219)

**Annual totals**

| | | | |
|---|---|---|---|
| Space heating fuel - main system 1 | | 2372.99 | |
| Water heating fuel | | 2069.33 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | (230c) |
| boiler flue fan | 45.00 | | (230e) |
| Total electricity for the above, kWh/year | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | 324.98 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 4842.30 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2372.99 | x | 3.48 | x 0.01 = | 82.58 | (240) |
| Water heating | 2069.33 | x | 3.48 | x 0.01 = | 72.01 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 324.98 | x | 13.19 | x 0.01 = | 42.86 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | (240)...(242) + (245)...(254) = | | 327.35 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.16 | (257) |
| SAP value | 83.88 | |
| SAP rating (section 13) | 84 | (258) |
| SAP band | B | |

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

| | Energy kWh/year | | Emission factor kg $CO_2$/kWh | | Emissions kg $CO_2$/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2372.99 | x | 0.216 | = | 512.57 | (261) |
| Water heating | 2069.33 | x | 0.216 | = | 446.98 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 959.54 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 324.98 | x | 0.519 | = | 168.66 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1167.13 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 15.77 | (273) |
| EI value | | | | | 86.86 | |
| EI rating (section 14) | | | | | 87 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2372.99 | x | 1.22 | = | 2895.04 | (261) |
| Water heating | 2069.33 | x | 1.22 | = | 2524.58 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 5419.63 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 324.98 | x | 3.07 | = | 997.69 | (268) |
| Primary energy kWh/year | | | | | 6647.56 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 89.83 | (273) |

# TER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco  Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 3B4P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 72.42 | (1a) | x | 2.50 | (2a) | = | 181.05 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 72.42 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 181.05 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 3 | x 10 = | 30 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

| | | | | Air changes per hour | |
|---|---|---|---|---|---|
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 30 | ÷ (5) = | 0.17 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.42 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.35 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.45 | 0.44 | 0.43 | 0.39 | 0.38 | 0.34 | 0.34 | 0.33 | 0.35 | 0.38 | 0.40 | 0.42 | (22b) |

Calculate effective air change rate for the applicable case:

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.60 | 0.60 | 0.59 | 0.58 | 0.57 | 0.56 | 0.56 | 0.55 | 0.56 | 0.57 | 0.58 | 0.59 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.60 | 0.60 | 0.59 | 0.58 | 0.57 | 0.56 | 0.56 | 0.55 | 0.56 | 0.57 | 0.58 | 0.59 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 15.02 | x | 1.33 | = | 19.91 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| External wall | | | 40.46 | x | 0.18 | = | 7.28 | | | (29a) |
| Party wall | | | 32.93 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 72.42 | x | 0.13 | = | 9.41 | | | (30) |
| Total area of external elements ∑A, m² | | | 129.70 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 38.41 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 16.00 | (36) |
| Total fabric heat loss | (33) + (36) = | 54.41 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 35.94 | 35.70 | 35.47 | 34.39 | 34.18 | 33.24 | 33.24 | 33.06 | 33.60 | 34.18 | 34.59 | 35.02 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 90.35 | 90.12 | 89.89 | 88.80 | 88.60 | 87.65 | 87.65 | 87.48 | 88.02 | 88.60 | 89.01 | 89.44 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 88.80 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.25 | 1.24 | 1.24 | 1.23 | 1.22 | 1.21 | 1.21 | 1.21 | 1.22 | 1.22 | 1.23 | 1.23 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.23 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.30 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 88.91 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 97.80 | 94.24 | 90.68 | 87.13 | 83.57 | 80.02 | 80.02 | 83.57 | 87.13 | 90.68 | 94.24 | 97.80 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1066.87 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 145.03 | 126.84 | 130.89 | 114.11 | 109.50 | 94.49 | 87.56 | 100.47 | 101.67 | 118.49 | 129.34 | 140.45 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1398.84 | (45) |
| Distribution loss 0.15 x (45)m | 21.75 | 19.03 | 19.63 | 17.12 | 16.42 | 14.17 | 13.13 | 15.07 | 15.25 | 17.77 | 19.40 | 21.07 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.26 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.14 | (50) |
| Enter (50) or (54) in (55) | 0.14 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.65 | 151.79 | 158.51 | 140.84 | 137.11 | 121.21 | 115.17 | 128.09 | 128.40 | 146.11 | 156.07 | 168.07 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.65 | 151.79 | 158.51 | 140.84 | 137.11 | 121.21 | 115.17 | 128.09 | 128.40 | 146.11 | 156.07 | 168.07 |

∑(64)1...12 = 1724.01 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.32 | 62.13 | 65.62 | 59.32 | 58.50 | 52.80 | 51.21 | 55.50 | 55.19 | 61.49 | 64.39 | 68.79 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.15 | 16.12 | 13.11 | 9.93 | 7.42 | 6.26 | 6.77 | 8.80 | 11.81 | 15.00 | 17.50 | 18.66 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 202.88 | 204.98 | 199.68 | 188.38 | 174.13 | 160.73 | 151.78 | 149.67 | 154.98 | 166.27 | 180.53 | 193.93 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | (69) |
| Pump and fan gains (Table 5a) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |
| Losses e.g. evaporation (Table 5) | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | (71) |
| Water heating gains (Table 5) | 94.51 | 92.46 | 88.19 | 82.40 | 78.63 | 73.33 | 68.83 | 74.60 | 76.65 | 82.65 | 89.43 | 92.47 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 376.09 | 374.12 | 361.53 | 341.26 | 320.73 | 300.87 | 287.92 | 293.62 | 303.99 | 324.47 | 348.01 | 365.60 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.77 | x | 10.54 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 63.26 | (80) |
| South | 0.77 | x | 4.48 | x | 46.75 | x 0.9 x | 0.63 | x | 0.70 | = | 64.01 | (78) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 127.27 | 228.59 | 337.35 | 448.18 | 521.57 | 524.27 | 502.91 | 448.58 | 376.54 | 259.92 | 154.76 | 107.34 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 503.37 | 602.71 | 698.89 | 789.43 | 842.30 | 825.15 | 790.84 | 742.20 | 680.53 | 584.39 | 502.76 | 472.94 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 0.99 | 0.97 | 0.93 | 0.82 | 0.64 | 0.48 | 0.53 | 0.78 | 0.96 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.72 | 19.91 | 20.21 | 20.56 | 20.83 | 20.96 | 20.99 | 20.99 | 20.90 | 20.54 | 20.06 | 19.68 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.88 | 19.88 | 19.89 | 19.90 | 19.90 | 19.91 | 19.91 | 19.91 | 19.91 | 19.90 | 19.90 | 19.89 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.99 | 0.97 | 0.90 | 0.76 | 0.55 | 0.37 | 0.41 | 0.69 | 0.93 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.19 | 18.47 | 18.90 | 19.40 | 19.74 | 19.89 | 19.91 | 19.91 | 19.83 | 19.38 | 18.69 | 18.15 | (90) |

Living area fraction Living area ÷ (4) = 0.38 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.76 | 19.01 | 19.39 | 19.84 | 20.15 | 20.29 | 20.32 | 20.31 | 20.23 | 19.81 | 19.21 | 18.72 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.76 | 19.01 | 19.39 | 19.84 | 20.15 | 20.29 | 20.32 | 20.31 | 20.23 | 19.81 | 19.21 | 18.72 | (93) |

## 8. Space heating requirement

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

Utilisation factor for gains, ηm

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.96 | 0.90 | 0.77 | 0.58 | 0.41 | 0.46 | 0.72 | 0.93 | 0.99 | 0.99 | (94) |

Useful gains, ηmGm, W (94)m x (84)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 499.89 | 593.24 | 672.02 | 710.75 | 652.75 | 480.35 | 323.00 | 337.92 | 490.30 | 545.16 | 495.59 | 470.45 | (95) |

Monthly average external temperature from Table U1

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1306.68 | 1271.87 | 1158.69 | 971.29 | 748.51 | 498.70 | 325.66 | 342.35 | 539.85 | 816.34 | 1077.48 | 1299.01 | (97) |

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 600.25 | 456.04 | 362.08 | 187.59 | 71.24 | 0.00 | 0.00 | 0.00 | 0.00 | 201.75 | 418.96 | 616.45 |

∑(98)1...5, 10...12 = 2914.36 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 40.24 (99)

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

**Space heating**

Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201)

Fraction of space heat from main system(s) 1 - (201) = 1.00 (202)

Fraction of space heat from main system 2 0.00 (202)

Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204)

Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205)

Efficiency of main system 1 (%) 93.50 (206)

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 641.98 | 487.74 | 387.25 | 200.63 | 76.19 | 0.00 | 0.00 | 0.00 | 0.00 | 215.78 | 448.09 | 659.30 |

∑(211)1...5, 10...12 = 3116.96 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.87 | 87.57 | 86.95 | 85.58 | 83.16 | 79.80 | 79.80 | 79.80 | 79.80 | 85.67 | 87.32 | 87.97 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 196.48 | 173.34 | 182.30 | 164.57 | 164.87 | 151.90 | 144.33 | 160.51 | 160.90 | 170.53 | 178.72 | 191.05 |

∑(219a)1...12 = 2039.51 (219)

**Annual totals**

|  |  |  |  |  |
|---|---|---|---|---|
| Space heating fuel - main system 1 |  |  | 3116.96 |  |
| Water heating fuel |  |  | 2039.51 |  |
| Electricity for pumps, fans and electric keep-hot (Table 4f) |  |  |  |  |
| central heating pump or water pump within warm air heating unit | 30.00 |  |  | (230c) |
| boiler flue fan | 45.00 |  |  | (230e) |
| Total electricity for the above, kWh/year |  |  | 75.00 | (231) |
| Electricity for lighting (Appendix L) |  |  | 320.59 | (232) |
| Total delivered energy for all uses |  | (211)...(221) + (231) + (232)...(237b) = | 5552.07 | (238) |

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

|  | Fuel kWh/year |  | Fuel price |  | Fuel cost £/year |  |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3116.96 | x | 3.48 | x 0.01 = | 108.47 | (240) |
| Water heating | 2039.51 | x | 3.48 | x 0.01 = | 70.98 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 320.59 | x | 13.19 | x 0.01 = | 42.29 | (250) |
| Additional standing charges |  |  |  |  | 120.00 | (251) |
| Total energy cost |  |  | (240)...(242) + (245)...(254) = |  | 351.62 | (255) |

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

|  |  |  |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.26 | (257) |
| SAP value | 82.45 |  |
| SAP rating (section 13) | 82 | (258) |
| SAP band | B |  |

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

|  | Energy kWh/year |  | Emission factor kg $CO_2$/kWh |  | Emissions kg $CO_2$/year |  |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3116.96 | x | 0.216 | = | 673.26 | (261) |
| Water heating | 2039.51 | x | 0.216 | = | 440.53 | (264) |
| Space and water heating |  |  | (261) + (262) + (263) + (264) = |  | 1113.80 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 320.59 | x | 0.519 | = | 166.39 | (268) |
| Total $CO_2$, kg/year |  |  | (265)...(271) = |  | 1319.11 | (272) |
| Dwelling $CO_2$ emission rate |  |  | (272) ÷ (4) = |  | 18.21 | (273) |
| EI value |  |  |  |  | 84.95 |  |
| EI rating (section 14) |  |  |  |  | 85 | (274) |
| EI band |  |  |  |  | B |  |

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

|  | Energy kWh/year |  | Primary factor |  | Primary Energy kWh/year |  |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3116.96 | x | 1.22 | = | 3802.69 | (261) |
| Water heating | 2039.51 | x | 1.22 | = | 2488.21 | (264) |
| Space and water heating |  |  | (261) + (262) + (263) + (264) = |  | 6290.90 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 320.59 | x | 3.07 | = | 984.22 | (268) |
| Primary energy kWh/year |  |  |  |  | 7505.37 | (272) |
| Dwelling primary energy rate kWh/m2/year |  |  |  |  | 103.64 | (273) |

# TER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 3B5P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 104.07 | (1a) | x | 2.50 | (2a) | = | 260.18 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 104.07 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 260.18 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 4 | x 10 = | 40 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

| | | | | Air changes per hour | |
|---|---|---|---|---|---|
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 40 | ÷ (5) = | 0.15 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.40 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.34 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.44 | 0.43 | 0.42 | 0.38 | 0.37 | 0.33 | 0.33 | 0.32 | 0.34 | 0.37 | 0.39 | 0.40 | (22b) |

Calculate effective air change rate for the applicable case:

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.60 | 0.59 | 0.59 | 0.57 | 0.57 | 0.55 | 0.55 | 0.55 | 0.56 | 0.57 | 0.57 | 0.58 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.60 | 0.59 | 0.59 | 0.57 | 0.57 | 0.55 | 0.55 | 0.55 | 0.56 | 0.57 | 0.57 | 0.58 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 18.08 | x | 1.33 | = | 23.97 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| Ground floor | | | 104.07 | x | 0.13 | = | 13.53 | | | (28a) |
| External wall | | | 65.40 | x | 0.18 | = | 11.77 | | | (29a) |
| Party wall | | | 24.13 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 189.35 | | | | | | | (31) |

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 51.07 (33)

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

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

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 10.99 (36)

Total fabric heat loss (33) + (36) = 62.06 (37)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 51.15 | 50.83 | 50.52 | 49.05 | 48.77 | 47.49 | 47.49 | 47.25 | 47.98 | 48.77 | 49.33 | 49.91 | (38) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 113.21 | 112.89 | 112.58 | 111.11 | 110.84 | 109.56 | 109.56 | 109.32 | 110.05 | 110.84 | 111.39 | 111.97 |

Average = ∑(39)1...12/12 = 111.11 (39)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.09 | 1.08 | 1.08 | 1.07 | 1.07 | 1.05 | 1.05 | 1.05 | 1.06 | 1.07 | 1.07 | 1.08 |

Average = ∑(40)1...12/12 = 1.07 (40)

Number of days in month (Table 1a)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

Assumed occupancy, N 2.77 (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 100.09 (43)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 110.09 | 106.09 | 102.09 | 98.08 | 94.08 | 90.08 | 90.08 | 94.08 | 98.08 | 102.09 | 106.09 | 110.09 |

∑(44)1...12 = 1201.03 (44)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 163.27 | 142.79 | 147.35 | 128.46 | 123.26 | 106.37 | 98.57 | 113.11 | 114.46 | 133.39 | 145.60 | 158.12 |

∑(45)1...12 = 1574.74 (45)

Distribution loss 0.15 x (45)m

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24.49 | 21.42 | 22.10 | 19.27 | 18.49 | 15.96 | 14.78 | 16.97 | 17.17 | 20.01 | 21.84 | 23.72 | (46) |

Storage volume (litres) including any solar or WWHRS storage within same vessel 3.00 (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day) 0.26 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage (kWh/day) (48) x (49) 0.14 (50)

Enter (50) or (54) in (55) 0.14 (55)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Primary circuit loss for each month from Table 3 | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |
| Combi loss for each month from Table 3a, 3b or 3c | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (61) |
| Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m | 190.88 | 167.74 | 174.97 | 155.19 | 150.88 | 133.09 | 126.18 | 140.72 | 141.18 | 161.01 | 172.33 | 185.73 | (62) |
| Solar DHW input calculated using Appendix G or Appendix H | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (63) |
| Output from water heater for each month (kWh/month) (62)m + (63)m | 190.88 | 167.74 | 174.97 | 155.19 | 150.88 | 133.09 | 126.18 | 140.72 | 141.18 | 161.01 | 172.33 | 185.73 | |

∑(64)1...12 = 1899.92 (64)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m] | 76.38 | 67.44 | 71.09 | 64.10 | 63.08 | 56.75 | 54.87 | 59.70 | 59.44 | 66.45 | 69.79 | 74.67 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 24.07 | 21.38 | 17.38 | 13.16 | 9.84 | 8.31 | 8.97 | 11.66 | 15.66 | 19.88 | 23.20 | 24.73 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 262.74 | 265.47 | 258.60 | 243.97 | 225.51 | 208.16 | 196.56 | 193.84 | 200.71 | 215.33 | 233.80 | 251.15 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | (69) |
| Pump and fan gains (Table 5a) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |
| Losses e.g. evaporation (Table 5) | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | (71) |
| Water heating gains (Table 5) | 102.66 | 100.35 | 95.55 | 89.02 | 84.78 | 78.82 | 73.75 | 80.24 | 82.55 | 89.31 | 96.94 | 100.36 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 457.08 | 454.81 | 439.14 | 413.77 | 387.74 | 362.89 | 346.90 | 353.36 | 366.53 | 392.14 | 421.55 | 443.86 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.77 | x | 6.86 | x | 10.63 | x 0.9 x | 0.63 | x | 0.70 | = | 22.29 | (74) |
| NorthEast | 0.77 | x | 2.18 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 7.52 | (75) |
| East | 0.77 | x | 6.78 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 40.70 | (76) |
| SouthEast | 0.77 | x | 2.26 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 25.41 | (77) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | 95.92 | 180.80 | 290.29 | 426.15 | 534.03 | 554.06 | 524.31 | 440.87 | 337.24 | 211.72 | 118.14 | 79.94 | (83) |
| Total gains - internal and solar (73)m + (83)m | 553.00 | 635.61 | 729.44 | 839.92 | 921.78 | 916.95 | 871.21 | 794.23 | 703.77 | 603.85 | 539.69 | 523.80 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 1.00 | 0.99 | 0.97 | 0.89 | 0.71 | 0.54 | 0.61 | 0.87 | 0.98 | 1.00 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.78 | 19.92 | 20.17 | 20.51 | 20.80 | 20.96 | 20.99 | 20.98 | 20.87 | 20.49 | 20.08 | 19.76 | (87) |

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

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

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 1.00 | 0.99 | 0.96 | 0.84 | 0.63 | 0.43 | 0.50 | 0.81 | 0.98 | 1.00 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.37 | 18.58 | 18.94 | 19.45 | 19.83 | 20.01 | 20.04 | 20.04 | 19.92 | 19.42 | 18.82 | 18.35 | (90) |

Living area fraction Living area ÷ (4) = 0.32 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.82 | 19.01 | 19.34 | 19.79 | 20.14 | 20.31 | 20.34 | 20.34 | 20.23 | 19.76 | 19.22 | 18.80 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.82 | 19.01 | 19.34 | 19.79 | 20.14 | 20.31 | 20.34 | 20.34 | 20.23 | 19.76 | 19.22 | 18.80 | (93) |

## 8. Space heating requirement

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

Utilisation factor for gains, ηm

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 1.00 | 0.99 | 0.95 | 0.85 | 0.65 | 0.47 | 0.53 | 0.82 | 0.97 | 1.00 | 1.00 | (94) |

Useful gains, ηmGm, W (94)m x (84)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 551.81 | 632.58 | 719.53 | 799.23 | 782.37 | 598.20 | 406.23 | 423.26 | 580.28 | 588.06 | 537.23 | 522.94 | (95) |

Monthly average external temperature from Table U1

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1644.00 | 1592.61 | 1445.16 | 1209.64 | 935.87 | 625.90 | 409.97 | 430.60 | 674.14 | 1015.33 | 1349.90 | 1634.71 | (97) |

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 812.59 | 645.14 | 539.87 | 295.49 | 114.20 | 0.00 | 0.00 | 0.00 | 0.00 | 317.88 | 585.13 | 827.16 |

∑(98)1...5, 10...12 = 4137.46 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 39.76 (99)

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

**Space heating**

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | | 0.00 | (201) |
| Fraction of space heat from main system(s) | 1 - (201) = | 1.00 | (202) |
| Fraction of space heat from main system 2 | | 0.00 | (202) |
| Fraction of total space heat from main system 1 | (202) x [1- (203)] = | 1.00 | (204) |
| Fraction of total space heat from main system 2 | (202) x (203) = | 0.00 | (205) |
| Efficiency of main system 1 (%) | | 93.50 | (206) |

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 869.08 | 689.99 | 577.40 | 316.03 | 122.14 | 0.00 | 0.00 | 0.00 | 0.00 | 339.98 | 625.80 | 884.66 |

∑(211)1...5, 10...12 = 4425.09 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88.25 | 88.06 | 87.62 | 86.51 | 84.08 | 79.80 | 79.80 | 79.80 | 79.80 | 86.60 | 87.82 | 88.33 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 216.30 | 190.48 | 199.68 | 179.40 | 179.44 | 166.79 | 158.12 | 176.34 | 176.92 | 185.93 | 196.23 | 210.28 |

| | | | |
|---|---|---|---|
| | ∑(219a)1...12 = | 2235.91 | (219) |

**Annual totals**

| | | | |
|---|---|---|---|
| Space heating fuel - main system 1 | | 4425.09 | |
| Water heating fuel | | 2235.91 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | (230c) |
| boiler flue fan | 45.00 | | (230e) |
| Total electricity for the above, kWh/year | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | 425.01 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 7161.01 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 4425.09 | x | 3.48 | x 0.01 = | 153.99 | (240) |
| Water heating | 2235.91 | x | 3.48 | x 0.01 = | 77.81 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 425.01 | x | 13.19 | x 0.01 = | 56.06 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 417.75 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.18 | (257) |
| SAP value | 83.58 | |
| SAP rating (section 13) | 84 | (258) |
| SAP band | B | |

## 12a. CO$_2$ emissions - individual heating systems including micro-CHP

| | Energy kWh/year | | Emission factor kg CO$_2$/kWh | | Emissions kg CO$_2$/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 4425.09 | x | 0.216 | = | 955.82 | (261) |
| Water heating | 2235.91 | x | 0.216 | = | 482.96 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 1438.78 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 425.01 | x | 0.519 | = | 220.58 | (268) |
| Total CO$_2$, kg/year | | | | (265)...(271) = | 1698.28 | (272) |
| Dwelling CO$_2$ emission rate | | | | (272) ÷ (4) = | 16.32 | (273) |
| EI value | | | | | 84.73 | |
| EI rating (section 14) | | | | | 85 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 4425.09 | x | 1.22 | = | 5398.61 | (261) |
| Water heating | 2235.91 | x | 1.22 | = | 2727.81 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 8126.42 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 425.01 | x | 3.07 | = | 1304.79 | (268) |

| | | |
|---|---|---|
| Primary energy kWh/year | 9661.46 | (272) |
| Dwelling primary energy rate kWh/m2/year | 92.84 | (273) |

# TER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 3B6P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 94.73 | (1a) | x | 2.50 | (2a) | = | 236.83 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 94.73 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 236.83 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 3 | x 10 = | 30 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

| | | | | Air changes per hour | |
|---|---|---|---|---|---|
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 30 | ÷ (5) = | 0.13 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.38 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.32 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.41 | 0.40 | 0.39 | 0.35 | 0.34 | 0.30 | 0.30 | 0.30 | 0.32 | 0.34 | 0.36 | 0.38 | (22b) |

Calculate effective air change rate for the applicable case:

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.58 | 0.58 | 0.58 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.58 | 0.58 | 0.58 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 14.86 | x | 1.33 | = | 19.70 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| External wall | | | 70.96 | x | 0.18 | = | 12.77 | | | (29a) |
| Party wall | | | 15.15 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 94.73 | x | 0.13 | = | 12.31 | | | (30) |
| Total area of external elements ∑A, m² | | | 182.35 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 46.59 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 17.18 | (36) |
| Total fabric heat loss | (33) + (36) = | 63.77 | (37) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45.59 | 45.34 | 45.09 | 43.92 | 43.71 | 42.69 | 42.69 | 42.50 | 43.08 | 43.71 | 44.15 | 44.61 | (38) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 109.36 | 109.11 | 108.86 | 107.69 | 107.48 | 106.46 | 106.46 | 106.27 | 106.85 | 107.48 | 107.92 | 108.38 |

Average = ∑(39)1...12/12 = 107.69 (39)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.15 | 1.15 | 1.15 | 1.14 | 1.13 | 1.12 | 1.12 | 1.12 | 1.13 | 1.13 | 1.14 | 1.14 |

Average = ∑(40)1...12/12 = 1.14 (40)

Number of days in month (Table 1a)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.69 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 97.97 | (43) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 107.77 | 103.85 | 99.93 | 96.01 | 92.09 | 88.17 | 88.17 | 92.09 | 96.01 | 99.93 | 103.85 | 107.77 |

∑(44)1...12 = 1175.65 (44)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 159.82 | 139.78 | 144.24 | 125.75 | 120.66 | 104.12 | 96.48 | 110.72 | 112.04 | 130.57 | 142.53 | 154.77 |

∑(45)1...12 = 1541.46 (45)

Distribution loss 0.15 x (45)m

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.97 | 20.97 | 21.64 | 18.86 | 18.10 | 15.62 | 14.47 | 16.61 | 16.81 | 19.59 | 21.38 | 23.22 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.26 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.14 | (50) |
| Enter (50) or (54) in (55) | 0.14 | (55) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 187.43 | 164.72 | 171.85 | 152.48 | 148.28 | 130.85 | 124.10 | 138.33 | 138.76 | 158.19 | 169.25 | 182.39 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 187.43 | 164.72 | 171.85 | 152.48 | 148.28 | 130.85 | 124.10 | 138.33 | 138.76 | 158.19 | 169.25 | 182.39 |

∑(64)1...12 = 1866.64 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 75.23 | 66.43 | 70.05 | 63.19 | 62.21 | 56.00 | 54.17 | 58.91 | 58.63 | 65.51 | 68.77 | 73.56 | (65) |

## 5. Internal gains

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

Metabolic gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | (66) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.11 | 20.53 | 16.69 | 12.64 | 9.45 | 7.98 | 8.62 | 11.20 | 15.04 | 19.09 | 22.28 | 23.75 | (67) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 247.52 | 250.08 | 243.61 | 229.83 | 212.44 | 196.09 | 185.17 | 182.60 | 189.08 | 202.85 | 220.25 | 236.59 | (68) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | (69) |

Pump and fan gains (Table 5a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |

Losses e.g. evaporation (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 101.12 | 98.86 | 94.16 | 87.77 | 83.62 | 77.78 | 72.82 | 79.18 | 81.44 | 88.05 | 95.52 | 98.87 | (72) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 438.02 | 435.75 | 420.74 | 396.52 | 371.78 | 348.12 | 332.88 | 339.26 | 351.82 | 376.27 | 404.32 | 425.49 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.77 | x | 10.44 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 62.66 | (76) |
| South | 0.77 | x | 4.42 | x | 46.75 | x 0.9 x | 0.63 | x | 0.70 | = | 63.15 | (78) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 125.82 | 226.01 | 333.63 | 443.33 | 516.00 | 518.71 | 497.57 | 443.77 | 372.42 | 257.01 | 152.99 | 106.10 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 563.84 | 661.76 | 754.37 | 839.85 | 887.79 | 866.83 | 830.45 | 783.02 | 724.25 | 633.29 | 557.32 | 531.59 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 1.00 | 0.99 | 0.96 | 0.88 | 0.72 | 0.55 | 0.60 | 0.84 | 0.98 | 1.00 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.75 | 19.91 | 20.17 | 20.51 | 20.78 | 20.95 | 20.99 | 20.98 | 20.87 | 20.50 | 20.06 | 19.72 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.96 | 19.96 | 19.96 | 19.97 | 19.97 | 19.98 | 19.98 | 19.98 | 19.98 | 19.97 | 19.97 | 19.97 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.94 | 0.84 | 0.63 | 0.43 | 0.48 | 0.77 | 0.96 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.29 | 18.53 | 18.91 | 19.39 | 19.76 | 19.94 | 19.98 | 19.98 | 19.88 | 19.39 | 18.75 | 18.25 | (90) |

Living area fraction Living area ÷ (4) = 0.33 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.77 | 18.98 | 19.33 | 19.76 | 20.10 | 20.27 | 20.31 | 20.31 | 20.21 | 19.76 | 19.18 | 18.74 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.77 | 18.98 | 19.33 | 19.76 | 20.10 | 20.27 | 20.31 | 20.31 | 20.21 | 19.76 | 19.18 | 18.74 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 1.00 | 0.99 | 0.98 | 0.94 | 0.84 | 0.66 | 0.47 | 0.52 | 0.79 | 0.96 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 561.77 | 656.23 | 738.29 | 788.83 | 747.77 | 571.68 | 390.33 | 407.53 | 571.85 | 607.49 | 552.98 | 530.13 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1582.30 | 1536.62 | 1396.13 | 1169.14 | 902.40 | 604.04 | 395.00 | 415.24 | 652.35 | 984.33 | 1304.13 | 1575.32 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 759.27 | 591.62 | 489.44 | 273.82 | 115.04 | 0.00 | 0.00 | 0.00 | 0.00 | 280.37 | 540.82 | 777.63 | |

∑(98)1...5, 10...12 = 3828.02 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 40.41 (99)

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

**Space heating**

Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201)

Fraction of space heat from main system(s) 1 - (201) = 1.00 (202)

Fraction of space heat from main system 2 0.00 (202)

Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204)

Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205)

Efficiency of main system 1 (%) 93.50 (206)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating fuel (main system 1), kWh/month | 812.06 | 632.75 | 523.46 | 292.86 | 123.04 | 0.00 | 0.00 | 0.00 | 0.00 | 299.86 | 578.42 | 831.69 |

∑(211)1...5, 10...12 = 4094.13 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 88.16 | 87.93 | 87.45 | 86.36 | 84.15 | 79.80 | 79.80 | 79.80 | 79.80 | 86.32 | 87.70 | 88.25 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 212.61 | 187.33 | 196.51 | 176.56 | 176.21 | 163.97 | 155.51 | 173.35 | 173.89 | 183.25 | 193.00 | 206.67 |

∑(219a)1...12 = 2198.86 (219)

**Annual totals**

| | | | |
|---|---|---|---|
| Space heating fuel - main system 1 | | 4094.13 | |
| Water heating fuel | | 2198.86 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | (230c) |
| boiler flue fan | 45.00 | | (230e) |
| Total electricity for the above, kWh/year | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | 408.17 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 6776.16 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 4094.13 | x | 3.48 | x 0.01 = | 142.48 | (240) |
| Water heating | 2198.86 | x | 3.48 | x 0.01 = | 76.52 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 408.17 | x | 13.19 | x 0.01 = | 53.84 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 402.73 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.21 | (257) |
| SAP value | 83.11 | |
| SAP rating (section 13) | 83 | (258) |
| SAP band | B | |

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

| | Energy kWh/year | | Emission factor kg $CO_2$/kWh | | Emissions kg $CO_2$/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 4094.13 | x | 0.216 | = | 884.33 | (261) |
| Water heating | 2198.86 | x | 0.216 | = | 474.95 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 1359.29 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 408.17 | x | 0.519 | = | 211.84 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1610.05 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 17.00 | (273) |
| EI value | | | | | 84.56 | |
| EI rating (section 14) | | | | | 85 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 4094.13 | x | 1.22 | = | 4994.84 | (261) |
| Water heating | 2198.86 | x | 1.22 | = | 2682.61 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 7677.45 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 408.17 | x | 3.07 | = | 1253.08 | (268) |
| Primary energy kWh/year | | | | | 9160.78 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 96.70 | (273) |

# TER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 23/10/2020 |
| Address | 4B8P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 72.24 | (1a) | x | 2.50 | (2a) | = | 180.60 | (3a) |
| +1 | | 57.20 | (1b) | x | 2.50 | (2b) | = | 143.00 | (3b) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 129.44 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 323.60 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 4 | x 10 = | 40 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |
| | | | Air changes per hour | |
| Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) = | 40 | ÷ (5) = | 0.12 | (8) |

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

| | | |
|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | 0.37 | (18) |
| Number of sides on which the dwelling is sheltered | 2 | (19) |
| Shelter factor 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor (18) x (20) = | 0.32 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.40 | 0.40 | 0.39 | 0.35 | 0.34 | 0.30 | 0.30 | 0.29 | 0.32 | 0.34 | 0.36 | 0.37 | (22b) |

Calculate effective air change rate for the applicable case:

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

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.58 | 0.58 | 0.58 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (24d) |

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

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

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 23.72 | x | 1.33 | = | 31.45 | | | (27) |
| Door | | | 1.80 | x | 1.00 | = | 1.80 | | | (26) |
| Ground floor | | | 72.24 | x | 0.13 | = | 9.39 | | | (28a) |
| External wall | | | 64.31 | x | 0.18 | = | 11.58 | | | (29a) |
| Party wall | | | 79.95 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 17.62 | x | 0.13 | = | 2.29 | | | (30) |
| Total area of external elements ∑A, m² | | | 179.69 | | | | | | | (31) |

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 56.50 (33)

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

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

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 9.46 (36)

Total fabric heat loss (33) + (36) = 65.96 (37)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62.15 | 61.81 | 61.47 | 59.91 | 59.62 | 58.25 | 58.25 | 58.00 | 58.78 | 59.62 | 60.21 | 60.83 | (38) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 128.11 | 127.77 | 127.44 | 125.87 | 125.58 | 124.22 | 124.22 | 123.96 | 124.74 | 125.58 | 126.17 | 126.79 | |

Average = ∑(39)1...12/12 = 125.87 (39)

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

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

Average = ∑(40)1...12/12 = 0.97 (40)

Number of days in month (Table 1a)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

Assumed occupancy, N 2.89 (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 102.92 (43)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 113.21 | 109.10 | 104.98 | 100.86 | 96.75 | 92.63 | 92.63 | 96.75 | 100.86 | 104.98 | 109.10 | 113.21 | |

∑(44)1...12 = 1235.05 (44)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 167.89 | 146.84 | 151.53 | 132.10 | 126.76 | 109.38 | 101.36 | 116.31 | 117.70 | 137.17 | 149.73 | 162.59 | |

∑(45)1...12 = 1619.35 (45)

Distribution loss 0.15 x (45)m

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25.18 | 22.03 | 22.73 | 19.82 | 19.01 | 16.41 | 15.20 | 17.45 | 17.65 | 20.57 | 22.46 | 24.39 | (46) |

Storage volume (litres) including any solar or WWHRS storage within same vessel 3.00 (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day) 0.26 (48)

Temperature factor from Table 2b 0.54 (49)

Energy lost from water storage (kWh/day) (48) x (49) 0.14 (50)

Enter (50) or (54) in (55) 0.14 (55)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (56) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | | | | | | | | | | | | | |
| | 4.36 | 3.93 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | 4.36 | 4.21 | 4.36 | 4.21 | 4.36 | (57) |
| Primary circuit loss for each month from Table 3 | | | | | | | | | | | | | |
| | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |
| Combi loss for each month from Table 3a, 3b or 3c | | | | | | | | | | | | | |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (61) |
| Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m | | | | | | | | | | | | | |
| | 195.51 | 171.78 | 179.14 | 158.83 | 154.37 | 136.11 | 128.98 | 143.93 | 144.43 | 164.78 | 176.45 | 190.21 | (62) |
| Solar DHW input calculated using Appendix G or Appendix H | | | | | | | | | | | | | |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (63) |
| Output from water heater for each month (kWh/month) (62)m + (63)m | | | | | | | | | | | | | |
| | 195.51 | 171.78 | 179.14 | 158.83 | 154.37 | 136.11 | 128.98 | 143.93 | 144.43 | 164.78 | 176.45 | 190.21 | |
| | | | | | | | | | | | ∑(64)1...12 = | 1944.53 | (64) |
| Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m] | | | | | | | | | | | | | |
| | 77.92 | 68.78 | 72.48 | 65.31 | 64.24 | 57.75 | 55.80 | 60.77 | 60.52 | 67.70 | 71.17 | 76.16 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 26.97 | 23.96 | 19.48 | 14.75 | 11.03 | 9.31 | 10.06 | 13.07 | 17.55 | 22.28 | 26.00 | 27.72 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 297.04 | 300.13 | 292.36 | 275.82 | 254.95 | 235.33 | 222.22 | 219.14 | 226.91 | 243.45 | 264.32 | 283.94 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | (69) |
| Pump and fan gains (Table 5a) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |
| Losses e.g. evaporation (Table 5) | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | (71) |
| Water heating gains (Table 5) | 104.73 | 102.35 | 97.41 | 90.70 | 86.34 | 80.21 | 74.99 | 81.68 | 84.05 | 91.00 | 98.84 | 102.36 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 498.15 | 495.84 | 478.66 | 450.68 | 421.72 | 394.25 | 376.68 | 383.29 | 397.91 | 426.13 | 458.57 | 483.42 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.77 | x | 9.04 | x | 46.75 | x 0.9 x | 0.63 | x | 0.70 | = | 129.16 | (78) |
| East | 0.77 | x | 10.68 | x | 19.64 | x 0.9 x | 0.63 | x | 0.70 | = | 64.10 | (76) |
| SouthEast | 0.77 | x | 4.00 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 44.98 | (77) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | 238.25 | 413.56 | 580.81 | 735.63 | 831.97 | 827.72 | 797.40 | 726.43 | 635.18 | 461.64 | 286.91 | 202.82 | (83) |
| Total gains - internal and solar (73)m + (83)m | 736.40 | 909.39 | 1059.47 | 1186.31 | 1253.69 | 1221.97 | 1174.08 | 1109.72 | 1033.09 | 887.77 | 745.48 | 686.24 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 0.99 | 0.98 | 0.94 | 0.82 | 0.63 | 0.46 | 0.51 | 0.77 | 0.96 | 1.00 | 1.00 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 19.95 | 20.14 | 20.40 | 20.69 | 20.90 | 20.98 | 21.00 | 21.00 | 20.95 | 20.66 | 20.24 | 19.92 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C) | 20.09 | 20.09 | 20.10 | 20.11 | 20.11 | 20.12 | 20.12 | 20.12 | 20.11 | 20.11 | 20.10 | 20.10 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 1.00 | 0.99 | 0.98 | 0.91 | 0.77 | 0.55 | 0.37 | 0.41 | 0.69 | 0.95 | 0.99 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 18.68 | 18.96 | 19.33 | 19.75 | 20.01 | 20.11 | 20.12 | 20.12 | 20.07 | 19.72 | 19.12 | 18.64 | (90) |

Living area fraction Living area ÷ (4) = 0.30 (91)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | 19.06 | 19.31 | 19.65 | 20.03 | 20.28 | 20.37 | 20.38 | 20.38 | 20.34 | 20.00 | 19.46 | 19.03 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 19.06 | 19.31 | 19.65 | 20.03 | 20.28 | 20.37 | 20.38 | 20.38 | 20.34 | 20.00 | 19.46 | 19.03 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 1.00 | 0.99 | 0.97 | 0.91 | 0.78 | 0.58 | 0.40 | 0.44 | 0.71 | 0.94 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 734.27 | 901.01 | 1029.58 | 1083.14 | 978.76 | 703.13 | 468.45 | 491.21 | 734.73 | 838.13 | 739.84 | 684.88 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1891.51 | 1841.60 | 1676.03 | 1401.38 | 1077.08 | 716.73 | 469.81 | 493.65 | 778.09 | 1180.93 | 1559.03 | 1879.87 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 860.99 | 632.07 | 480.96 | 229.13 | 73.15 | 0.00 | 0.00 | 0.00 | 0.00 | 255.05 | 589.81 | 889.07 | |

∑(98)1...5, 10...12 = 4010.24 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 30.98 (99)

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

**Space heating**

Fraction of space heat from secondary/supplementary system (table 11) 0.00 (201)

Fraction of space heat from main system(s) 1 - (201) = 1.00 (202)

Fraction of space heat from main system 2 0.00 (202)

Fraction of total space heat from main system 1 (202) x [1- (203)] = 1.00 (204)

Fraction of total space heat from main system 2 (202) x (203) = 0.00 (205)

Efficiency of main system 1 (%) 93.50 (206)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating fuel (main system 1), kWh/month | 920.84 | 676.02 | 514.39 | 245.06 | 78.24 | 0.00 | 0.00 | 0.00 | 0.00 | 272.78 | 630.82 | 950.88 |

∑(211)1...5, 10...12 = 4289.02 (211)

**Water heating**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Efficiency of water heater | 88.31 | 87.98 | 87.32 | 85.79 | 82.95 | 79.80 | 79.80 | 79.80 | 79.80 | 85.98 | 87.79 | 88.41 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 221.39 | 195.26 | 205.15 | 185.14 | 186.10 | 170.56 | 161.62 | 180.36 | 180.98 | 191.66 | 201.00 | 215.15 |

| | | | |
|---|---|---|---|
| | ∑(219a)1...12 = | 2294.37 | (219) |

**Annual totals**

| | | | | |
|---|---|---|---|---|
| Space heating fuel - main system 1 | | | 4289.02 | |
| Water heating fuel | | | 2294.37 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | | (230c) |
| boiler flue fan | 45.00 | | | (230e) |
| Total electricity for the above, kWh/year | | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | | 476.33 | (232) |
| Total delivered energy for all uses | | (211)...(221) + (231) + (232)...(237b) = | 7134.73 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 4289.02 | x | 3.48 | x 0.01 = | 149.26 | (240) |
| Water heating | 2294.37 | x | 3.48 | x 0.01 = | 79.84 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 476.33 | x | 13.19 | x 0.01 = | 62.83 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 421.82 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.02 | (257) |
| SAP value | 85.83 | |
| SAP rating (section 13) | 86 | (258) |
| SAP band | B | |

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

| | Energy kWh/year | | Emission factor kg $CO_2$/kWh | | Emissions kg $CO_2$/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 4289.02 | x | 0.216 | = | 926.43 | (261) |
| Water heating | 2294.37 | x | 0.216 | = | 495.58 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 1422.01 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 476.33 | x | 0.519 | = | 247.22 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1708.16 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 13.20 | (273) |
| EI value | | | | | 86.88 | |
| EI rating (section 14) | | | | | 87 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 4289.02 | x | 1.22 | = | 5232.61 | (261) |
| Water heating | 2294.37 | x | 1.22 | = | 2799.13 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 8031.74 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| Electricity for lighting | 476.33 | x | 3.07 | = | 1462.34 | (268) |
| Primary energy kWh/year |  |  |  |  | 9724.33 | (272) |
| Dwelling primary energy rate kWh/m2/year |  |  |  |  | 75.13 | (273) |

# Appendix C DER Worksheets – *Be Lean*

# DER Worksheet
## Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 1B2P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 51.12 | (1a) | x | 2.50 | (2a) | = | 127.80 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 51.12 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 127.80 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

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

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 1 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.93 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.14 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.18 | 0.17 | 0.17 | 0.15 | 0.15 | 0.13 | 0.13 | 0.13 | 0.14 | 0.15 | 0.16 | 0.16 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 75.65 | (23c) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100] | 0.30 | 0.30 | 0.29 | 0.27 | 0.27 | 0.25 | 0.25 | 0.25 | 0.26 | 0.27 | 0.28 | 0.28 | (24a) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.30 | 0.30 | 0.29 | 0.27 | 0.27 | 0.25 | 0.25 | 0.25 | 0.26 | 0.27 | 0.28 | 0.28 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 8.18 | x | 1.24 | = | 10.11 | | | (27) |
| Door | | | 1.80 | x | 0.60 | = | 1.08 | | | (26) |
| Ground floor | | | 51.12 | x | 0.10 | = | 5.11 | | | (28a) |
| External wall | | | 18.25 | x | 0.17 | = | 3.10 | | | (29a) |
| Party wall | | | 17.80 | x | 0.00 | = | 0.00 | | | (32) |
| External wall | | | 25.45 | x | 0.15 | = | 3.82 | | | (29a) |
| External wall | | | 2.70 | x | 0.20 | = | 0.54 | | | (29a) |
| Total area of external elements ∑A, m² | | | 107.50 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 23.76 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 8.51 | (36) |
| Total fabric heat loss | (33) + (36) = | 32.27 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 12.60 | 12.45 | 12.30 | 11.57 | 11.43 | 10.69 | 10.69 | 10.55 | 10.99 | 11.43 | 11.72 | 12.01 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 44.86 | 44.72 | 44.57 | 43.84 | 43.69 | 42.96 | 42.96 | 42.82 | 43.26 | 43.69 | 43.99 | 44.28 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 43.80 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.88 | 0.87 | 0.87 | 0.86 | 0.85 | 0.84 | 0.84 | 0.84 | 0.85 | 0.85 | 0.86 | 0.87 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.86 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 1.72 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 75.12 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 82.64 | 79.63 | 76.63 | 73.62 | 70.62 | 67.61 | 67.61 | 70.62 | 73.62 | 76.63 | 79.63 | 82.64 | |
| ∑(44)1...12 = | | | | | | | | | | | | 901.49 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 122.55 | 107.18 | 110.60 | 96.42 | 92.52 | 79.84 | 73.98 | 84.90 | 85.91 | 100.12 | 109.29 | 118.68 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1181.99 | (45) |
| Distribution loss 0.15 x (45)m | 18.38 | 16.08 | 16.59 | 14.46 | 13.88 | 11.98 | 11.10 | 12.73 | 12.89 | 15.02 | 16.39 | 17.80 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |
| Water storage loss: | | |
| b) Manufacturer's declared loss factor is not known | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51) |
| Volume factor from Table 2a | 3.42 | (52) |
| Temperature factor from Table 2b | 0.60 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.13 | (54) |
| Enter (50) or (54) in (55) | 0.13 | (55) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149.85 | 131.84 | 137.90 | 122.85 | 119.83 | 106.26 | 101.29 | 112.20 | 112.33 | 127.42 | 135.71 | 145.98 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149.85 | 131.84 | 137.90 | 122.85 | 119.83 | 106.26 | 101.29 | 112.20 | 112.33 | 127.42 | 135.71 | 145.98 | |

∑(64)1...12 = 1503.47 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62.59 | 55.37 | 58.62 | 53.20 | 52.61 | 47.68 | 46.44 | 50.07 | 49.70 | 55.13 | 57.48 | 61.30 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | 86.16 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 13.96 | 12.40 | 10.09 | 7.64 | 5.71 | 4.82 | 5.21 | 6.77 | 9.08 | 11.54 | 13.46 | 14.35 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 150.14 | 151.70 | 147.77 | 139.42 | 128.87 | 118.95 | 112.32 | 110.77 | 114.69 | 123.05 | 133.60 | 143.52 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | 31.62 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | -68.92 | (71) |
| Water heating gains (Table 5) | 84.13 | 82.39 | 78.79 | 73.89 | 70.71 | 66.23 | 62.42 | 67.30 | 69.03 | 74.10 | 79.83 | 82.40 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 297.08 | 295.34 | 285.49 | 269.79 | 254.13 | 238.84 | 228.80 | 233.68 | 241.66 | 257.54 | 275.74 | 289.11 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.77 | x | 8.18 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 35.07 | (80) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 35.07 | 68.61 | 112.98 | 164.78 | 201.94 | 206.73 | 196.81 | 169.06 | 131.40 | 81.41 | 43.73 | 28.84 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 332.15 | 363.95 | 398.48 | 434.57 | 456.07 | 445.57 | 425.61 | 402.74 | 373.06 | 338.94 | 319.47 | 317.96 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 0.99 | 0.98 | 0.93 | 0.81 | 0.61 | 0.44 | 0.49 | 0.75 | 0.96 | 0.99 | 1.00 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 20.19 | 20.31 | 20.51 | 20.76 | 20.93 | 20.99 | 21.00 | 21.00 | 20.97 | 20.75 | 20.43 | 20.17 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C) | 20.19 | 20.19 | 20.19 | 20.20 | 20.21 | 20.22 | 20.22 | 20.22 | 20.21 | 20.21 | 20.20 | 20.20 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 1.00 | 0.99 | 0.98 | 0.91 | 0.76 | 0.54 | 0.36 | 0.41 | 0.68 | 0.94 | 0.99 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 19.10 | 19.27 | 19.56 | 19.92 | 20.14 | 20.21 | 20.22 | 20.22 | 20.19 | 19.92 | 19.46 | 19.09 | (90) |

Living area fraction — Living area ÷ (4) = 0.47 (91)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | 19.62 | 19.76 | 20.01 | 20.32 | 20.51 | 20.58 | 20.59 | 20.59 | 20.55 | 20.31 | 19.92 | 19.60 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 19.62 | 19.76 | 20.01 | 20.32 | 20.51 | 20.58 | 20.59 | 20.59 | 20.55 | 20.31 | 19.92 | 19.60 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.99 | 0.97 | 0.92 | 0.78 | 0.57 | 0.40 | 0.44 | 0.72 | 0.94 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 330.35 | 360.17 | 388.00 | 398.81 | 356.69 | 253.79 | 170.95 | 178.73 | 267.01 | 319.02 | 315.72 | 316.61 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 687.15 | 664.50 | 602.02 | 500.53 | 384.96 | 256.86 | 171.22 | 179.23 | 279.17 | 424.16 | 563.78 | 681.78 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 265.46 | 204.51 | 159.24 | 73.24 | 21.03 | 0.00 | 0.00 | 0.00 | 0.00 | 78.23 | 178.60 | 271.69 | |

∑(98)1...5, 10...12 = 1251.99 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 24.49 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from boilers | | 1.00 | (303a) |
| Fraction of total space heat from community boilers | (302) x (303a) = | 1.00 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community space heating | | 1.00 | (305) |
| Factor for charging method (Table 4c(3)) for community water heating | | 1.00 | (305a) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |

**Space heating**

| | | | | |
|---|---|---|---|---|
| Annual space heating requirement | 1251.99 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 1314.59 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1503.47 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1578.64 | (310a) |

| | | | | |
|---|---|---|---|---|
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 28.93 | (313) |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | |
| mechanical ventilation fans - balanced, extract or positive input from outside | 103.29 | | | (330a) |
| Total electricity for the above, kWh/year | | | 103.29 | (331) |
| Electricity for lighting (Appendix L) | | | 246.61 | (332) |
| Total delivered energy for all uses | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 3243.14 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 1314.59 | x | 4.24 | x 0.01 = | 55.74 | (340a) |
| Water heating from boilers | 1578.64 | x | 4.24 | x 0.01 = | 66.93 | (342a) |
| Pumps and fans | 103.29 | x | 13.19 | x 0.01 = | 13.62 | (349) |
| Electricity for lighting | 246.61 | x | 13.19 | x 0.01 = | 32.53 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 288.83 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.26 | (357) |
| SAP value | 82.39 | |
| SAP rating (section 13) | 82 | (358) |
| SAP band | B | |

## 12b. $CO_2$ emissions - community heating scheme

| | | Energy kWh/year | | Emission factor | | Emissions (kg/year) | |
|---|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| CO2 emissions from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 3232.66 | x | 0.216 | = | 698.25 | (367) |
| Electrical energy for community heat distribution | | 28.93 | x | 0.519 | = | 15.02 | (372) |
| Total CO2 associated with community systems | | | | | | 713.27 | (373) |
| Total CO2 associated with space and water heating | | | | | | 713.27 | (376) |
| Pumps and fans | | 103.29 | x | 0.519 | = | 53.61 | (378) |
| Electricity for lighting | | 246.61 | x | 0.519 | = | 127.99 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 894.87 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 17.51 | (384) |
| EI value | | | | | | 87.52 | |
| EI rating (section 14) | | | | | | 88 | (385) |
| EI band | | | | | | B | |

## 13b. Primary energy - community heating scheme

| | | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| Primary energy from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 3232.66 | x | 1.22 | = | 3943.85 | (367) |
| Electrical energy for community heat distribution | | 28.93 | x | 3.07 | = | 88.82 | (372) |
| Total primary energy associated with community systems | | | | | | 4032.67 | (373) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Total primary energy associated with space and water heating | | | | | 4032.67 | (376) |
| Pumps and fans | 103.29 | x | 3.07 | = | 317.11 | (378) |
| Electricity for lighting | 246.61 | x | 3.07 | = | 757.11 | (379) |
| Primary energy kWh/year | | | | | 5106.89 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 99.90 | (384) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 1B2P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 50.88 | (1a) | x | 2.50 | (2a) | = | 127.20 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 50.88 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 127.20 | (5) |

## 2. Ventilation rate

| | | | | m³ per hour | |
|---|---|---|---|---|---|
| Number of chimneys | | 0 | x 40 = | 0 | (6a) |
| Number of open flues | | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | 0 | x 40 = | 0 | (7c) |
| | | | | Air changes per hour | |
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 0 | ÷ (5) = | 0.00 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 3 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.78 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.12 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.15 | 0.15 | 0.14 | 0.13 | 0.12 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 | 0.13 | 0.14 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 75.65 | (23c) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100] | 0.27 | 0.27 | 0.26 | 0.25 | 0.25 | 0.23 | 0.23 | 0.23 | 0.24 | 0.25 | 0.25 | 0.26 | (24a) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.27 | 0.27 | 0.26 | 0.25 | 0.25 | 0.23 | 0.23 | 0.23 | 0.24 | 0.25 | 0.25 | 0.26 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m$^2$ | Openings m$^2$ | Net area A, m$^2$ | | U-value W/m$^2$K | | A x U W/K | κ-value, kJ/m$^2$.K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 7.76 | x | 1.24 | = | 9.59 | | | (27) |
| Door | | | 1.80 | x | 0.70 | = | 1.26 | | | (26) |
| External wall | | | 28.52 | x | 0.17 | = | 4.85 | | | (29a) |
| Party wall | | | 11.68 | x | 0.00 | = | 0.00 | | | (32) |
| External wall | | | 22.93 | x | 0.20 | = | 4.59 | | | (29a) |
| Total area of external elements ∑A, m$^2$ | | | 61.01 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 20.28 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m$^2$K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 7.20 | (36) |
| Total fabric heat loss | (33) + (36) = | 27.48 | (37) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 11.33 | 11.21 | 11.09 | 10.48 | 10.36 | 9.75 | 9.75 | 9.62 | 9.99 | 10.36 | 10.60 | 10.84 | (38) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 38.81 | 38.69 | 38.57 | 37.96 | 37.84 | 37.23 | 37.23 | 37.11 | 37.47 | 37.84 | 38.08 | 38.33 | |

Average = ∑(39)1...12/12 = 37.93 (39)

Heat loss parameter (HLP), W/m$^2$K (39)m ÷ (4)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.76 | 0.76 | 0.76 | 0.75 | 0.74 | 0.73 | 0.73 | 0.73 | 0.74 | 0.74 | 0.75 | 0.75 | |

Average = ∑(40)1...12/12 = 0.75 (40)

Number of days in month (Table 1a)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 1.72 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 74.96 | (43) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 82.45 | 79.45 | 76.45 | 73.46 | 70.46 | 67.46 | 67.46 | 70.46 | 73.46 | 76.45 | 79.45 | 82.45 | |

∑(44)1...12 = 899.47 (44)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 122.27 | 106.94 | 110.35 | 96.21 | 92.31 | 79.66 | 73.82 | 84.71 | 85.72 | 99.90 | 109.04 | 118.41 | |

∑(45)1...12 = 1179.35 (45)

Distribution loss 0.15 x (45)m

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.34 | 16.04 | 16.55 | 14.43 | 13.85 | 11.95 | 11.07 | 12.71 | 12.86 | 14.98 | 16.36 | 17.76 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |
| Water storage loss: | | |
| b) Manufacturer's declared loss factor is not known | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51) |
| Volume factor from Table 2a | 3.42 | (52) |
| Temperature factor from Table 2b | 0.60 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.13 | (54) |
| Enter (50) or (54) in (55) | 0.13 | (55) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149.58 | 131.60 | 137.66 | 122.63 | 119.62 | 106.08 | 101.12 | 112.01 | 112.14 | 127.20 | 135.47 | 145.72 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 149.58 | 131.60 | 137.66 | 122.63 | 119.62 | 106.08 | 101.12 | 112.01 | 112.14 | 127.20 | 135.47 | 145.72 |

∑(64)1...12 = 1500.82 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62.50 | 55.29 | 58.54 | 53.13 | 52.54 | 47.63 | 46.39 | 50.01 | 49.64 | 55.06 | 57.40 | 61.22 | (65) |

## 5. Internal gains

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

Metabolic gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | 85.80 | (66) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 14.04 | 12.47 | 10.14 | 7.68 | 5.74 | 4.85 | 5.24 | 6.81 | 9.14 | 11.60 | 13.54 | 14.43 | (67) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 149.52 | 151.07 | 147.16 | 138.84 | 128.33 | 118.46 | 111.86 | 110.31 | 114.22 | 122.54 | 133.05 | 142.92 | (68) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | 31.58 | (69) |

Pump and fan gains (Table 5a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |

Losses e.g. evaporation (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | -68.64 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 84.00 | 82.27 | 78.68 | 73.79 | 70.61 | 66.15 | 62.35 | 67.21 | 68.94 | 74.00 | 79.72 | 82.28 | (72) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 296.31 | 294.56 | 284.72 | 269.05 | 253.43 | 238.19 | 228.18 | 233.07 | 241.04 | 256.88 | 275.04 | 288.37 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.77 | x | 4.56 | x | 10.63 | x 0.9 x | 0.45 | x | 0.70 | = | 10.58 | (74) |
| East | 0.77 | x | 3.20 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 13.72 | (76) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24.30 | 47.07 | 78.57 | 119.67 | 153.37 | 160.49 | 151.33 | 125.11 | 92.73 | 55.92 | 30.16 | 20.11 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 320.61 | 341.62 | 363.29 | 388.72 | 406.80 | 398.68 | 379.51 | 358.18 | 333.77 | 312.81 | 305.21 | 308.48 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.94 | 0.81 | 0.59 | 0.43 | 0.48 | 0.74 | 0.95 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.35 | 20.44 | 20.60 | 20.81 | 20.95 | 21.00 | 21.00 | 21.00 | 20.98 | 20.81 | 20.55 | 20.33 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.29 | 20.29 | 20.29 | 20.30 | 20.30 | 20.31 | 20.31 | 20.32 | 20.31 | 20.30 | 20.30 | 20.29 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.92 | 0.76 | 0.53 | 0.36 | 0.41 | 0.68 | 0.94 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.41 | 19.54 | 19.78 | 20.08 | 20.26 | 20.31 | 20.31 | 20.31 | 20.29 | 20.09 | 19.71 | 19.39 | (90) |

Living area fraction — Living area ÷ (4) = 0.45 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.84 | 19.95 | 20.15 | 20.41 | 20.57 | 20.62 | 20.63 | 20.63 | 20.61 | 20.42 | 20.09 | 19.82 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.84 | 19.95 | 20.15 | 20.41 | 20.57 | 20.62 | 20.63 | 20.63 | 20.61 | 20.42 | 20.09 | 19.82 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | | | | | | | | | | | | | |
| | 0.99 | 0.99 | 0.98 | 0.92 | 0.78 | 0.56 | 0.39 | 0.44 | 0.71 | 0.94 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | | |
| | 318.87 | 338.35 | 354.81 | 358.81 | 317.30 | 222.73 | 149.75 | 156.61 | 236.58 | 293.94 | 301.50 | 307.17 | (95) |
| Monthly average external temperature from Table U1 | | | | | | | | | | | | | |
| | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | | | | | | | | | | | | | |
| | 603.01 | 582.26 | 526.48 | 437.04 | 335.76 | 224.18 | 149.85 | 156.82 | 243.77 | 371.40 | 494.80 | 598.63 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | | | | | | | | | | | | | |
| | 211.40 | 163.90 | 127.72 | 56.33 | 13.73 | 0.00 | 0.00 | 0.00 | 0.00 | 57.63 | 139.17 | 216.85 | |

∑(98)1...5, 10...12 = 986.74 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 19.39 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from boilers | | 1.00 | (303a) |
| Fraction of total space heat from community boilers | (302) x (303a) = | 1.00 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community space heating | | 1.00 | (305) |
| Factor for charging method (Table 4c(3)) for community water heating | | 1.00 | (305a) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |

**Space heating**

| | | | |
|---|---|---|---|
| Annual space heating requirement | 986.74 | | (98) |
| Space heat from boilers | (98) x (304a) x (305) x (306) = | 1036.08 | (307a) |

**Water heating**

| | | | |
|---|---|---|---|
| Annual water heating requirement | 1500.82 | | (64) |
| Water heat from boilers | (64) x (303a) x (305a) x (306) = | 1575.86 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 26.12 | (313) |

| | | | |
|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| mechanical ventilation fans - balanced, extract or positive input from outside | 102.81 | | (330a) |
| Total electricity for the above, kWh/year | | 102.81 | (331) |
| Electricity for lighting (Appendix L) | | 247.99 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 2962.74 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 1036.08 | x | 4.24 | x 0.01 = | 43.93 | (340a) |
| Water heating from boilers | 1575.86 | x | 4.24 | x 0.01 = | 66.82 | (342a) |
| Pumps and fans | 102.81 | x | 13.19 | x 0.01 = | 13.56 | (349) |
| Electricity for lighting | 247.99 | x | 13.19 | x 0.01 = | 32.71 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 277.02 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.21 | (357) |
| SAP value | 83.07 | |
| SAP rating (section 13) | 83 | (358) |
| SAP band | B | |

## 12b. $CO_2$ emissions - community heating scheme

| | | Energy kWh/year | | Emission factor | | Emissions (kg/year) | |
|---|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| CO2 emissions from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 2918.37 | x | 0.216 | = | 630.37 | (367) |
| Electrical energy for community heat distribution | | 26.12 | x | 0.519 | = | 13.56 | (372) |
| Total CO2 associated with community systems | | | | | | 643.92 | (373) |
| Total CO2 associated with space and water heating | | | | | | 643.92 | (376) |
| Pumps and fans | | 102.81 | x | 0.519 | = | 53.36 | (378) |
| Electricity for lighting | | 247.99 | x | 0.519 | = | 128.71 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 825.99 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 16.23 | (384) |
| EI value | | | | | | 88.46 | |
| EI rating (section 14) | | | | | | 88 | (385) |
| EI band | | | | | | B | |

## 13b. Primary energy - community heating scheme

| | | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| Primary energy from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 2918.37 | x | 1.22 | = | 3560.41 | (367) |
| Electrical energy for community heat distribution | | 26.12 | x | 3.07 | = | 80.19 | (372) |
| Total primary energy associated with community systems | | | | | | 3640.60 | (373) |
| Total primary energy associated with space and water heating | | | | | | 3640.60 | (376) |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| Pumps and fans | 102.81 | x | 3.07 | = | 315.62 | (378) |
| Electricity for lighting | 247.99 | x | 3.07 | = | 761.32 | (379) |
| Primary energy kWh/year |  |  |  |  | 4717.55 | (383) |
| Dwelling primary energy rate kWh/m2/year |  |  |  |  | 92.72 | (384) |

# DER Worksheet
## Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 1B2P, Kingston upon Thames, KT1 | | |

### 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 50.32 | (1a) | x | 2.50 | (2a) | = | 125.80 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 50.32 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 125.80 | (5) |

### 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

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

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.13 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.16 | 0.16 | 0.16 | 0.14 | 0.14 | 0.12 | 0.12 | 0.12 | 0.13 | 0.14 | 0.14 | 0.15 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 75.65 | (23c) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100] | 0.28 | 0.28 | 0.28 | 0.26 | 0.26 | 0.24 | 0.24 | 0.24 | 0.25 | 0.26 | 0.27 | 0.27 | (24a) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.28 | 0.28 | 0.28 | 0.26 | 0.26 | 0.24 | 0.24 | 0.24 | 0.25 | 0.26 | 0.27 | 0.27 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 7.86 | x | 1.24 | = | 9.71 | | | (27) |
| Door | | | 1.80 | x | 0.60 | = | 1.08 | | | (26) |
| External wall | | | 14.32 | x | 0.17 | = | 2.43 | | | (29a) |
| Party wall | | | 34.43 | x | 0.00 | = | 0.00 | | | (32) |
| External wall | | | 16.50 | x | 0.20 | = | 3.30 | | | (29a) |
| Roof | | | 50.32 | x | 0.13 | = | 6.54 | | | (30) |
| Total area of external elements ∑A, m² | | | 90.80 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 23.07 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 6.77 | (36) |
| Total fabric heat loss | (33) + (36) = | 29.84 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 11.80 | 11.67 | 11.54 | 10.88 | 10.74 | 10.08 | 10.08 | 9.95 | 10.35 | 10.74 | 11.01 | 11.27 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 41.64 | 41.51 | 41.38 | 40.72 | 40.58 | 39.92 | 39.92 | 39.79 | 40.19 | 40.58 | 40.85 | 41.11 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 40.68 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.83 | 0.82 | 0.82 | 0.81 | 0.81 | 0.79 | 0.79 | 0.79 | 0.80 | 0.81 | 0.81 | 0.82 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.81 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 1.70 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 74.56 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 82.02 | 79.04 | 76.06 | 73.07 | 70.09 | 67.11 | 67.11 | 70.09 | 73.07 | 76.06 | 79.04 | 82.02 | |
| ∑(44)1...12 = | | | | | | | | | | | | 894.76 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 121.63 | 106.38 | 109.78 | 95.71 | 91.83 | 79.24 | 73.43 | 84.26 | 85.27 | 99.37 | 108.47 | 117.80 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1173.18 | (45) |
| Distribution loss 0.15 x (45)m | 18.25 | 15.96 | 16.47 | 14.36 | 13.77 | 11.89 | 11.01 | 12.64 | 12.79 | 14.91 | 16.27 | 17.67 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |

Water storage loss:

b) Manufacturer's declared loss factor is not known

| | | |
|---|---|---|
| Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51) |
| Volume factor from Table 2a | 3.42 | (52) |
| Temperature factor from Table 2b | 0.60 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.13 | (54) |
| Enter (50) or (54) in (55) | 0.13 | (55) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 148.94 | 131.04 | 137.08 | 122.13 | 119.14 | 105.67 | 100.73 | 111.57 | 111.69 | 126.68 | 134.90 | 145.10 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 148.94 | 131.04 | 137.08 | 122.13 | 119.14 | 105.67 | 100.73 | 111.57 | 111.69 | 126.68 | 134.90 | 145.10 |

∑(64)1...12 = 1494.66 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 62.29 | 55.10 | 58.34 | 52.96 | 52.38 | 47.49 | 46.26 | 49.86 | 49.49 | 54.88 | 57.21 | 61.01 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 84.98 | 84.98 | 84.98 | 84.98 | 84.98 | 84.98 | 84.98 | 84.98 | 84.98 | 84.98 | 84.98 | 84.98 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 13.84 | 12.29 | 10.00 | 7.57 | 5.66 | 4.78 | 5.16 | 6.71 | 9.00 | 11.43 | 13.34 | 14.22 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 148.07 | 149.60 | 145.73 | 137.49 | 127.08 | 117.30 | 110.77 | 109.23 | 113.11 | 121.35 | 131.75 | 141.53 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | 31.50 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -67.98 | -67.98 | -67.98 | -67.98 | -67.98 | -67.98 | -67.98 | -67.98 | -67.98 | -67.98 | -67.98 | -67.98 | (71) |
| Water heating gains (Table 5) | 83.72 | 82.00 | 78.42 | 73.56 | 70.40 | 65.95 | 62.18 | 67.02 | 68.74 | 73.77 | 79.45 | 82.00 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 294.11 | 292.38 | 282.64 | 267.10 | 251.63 | 236.53 | 226.60 | 231.45 | 239.34 | 255.04 | 273.04 | 286.25 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.77 | x | 7.86 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 33.70 | (80) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33.70 | 65.92 | 108.56 | 158.33 | 194.04 | 198.64 | 189.11 | 162.44 | 126.26 | 78.22 | 42.02 | 27.71 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 327.81 | 358.30 | 391.20 | 425.44 | 445.67 | 435.16 | 415.71 | 393.90 | 365.60 | 333.26 | 315.06 | 313.96 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.98 | 0.92 | 0.79 | 0.58 | 0.42 | 0.46 | 0.73 | 0.95 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.27 | 20.38 | 20.57 | 20.80 | 20.95 | 20.99 | 21.00 | 21.00 | 20.98 | 20.79 | 20.49 | 20.25 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.23 | 20.23 | 20.23 | 20.25 | 20.25 | 20.26 | 20.26 | 20.26 | 20.25 | 20.25 | 20.24 | 20.24 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.97 | 0.90 | 0.74 | 0.52 | 0.35 | 0.39 | 0.66 | 0.93 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.25 | 19.41 | 19.69 | 20.02 | 20.20 | 20.26 | 20.26 | 20.26 | 20.24 | 20.01 | 19.59 | 19.23 | (90) |

| | | | |
|---|---|---|---|
| Living area fraction | Living area ÷ (4) = | 0.55 | (91) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.81 | 19.94 | 20.17 | 20.45 | 20.61 | 20.66 | 20.66 | 20.66 | 20.64 | 20.43 | 20.08 | 19.79 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.81 | 19.94 | 20.17 | 20.45 | 20.61 | 20.66 | 20.66 | 20.66 | 20.64 | 20.43 | 20.08 | 19.79 | (93) |

## 8. Space heating requirement

Utilisation factor for gains, ηm

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.99 | 0.97 | 0.91 | 0.76 | 0.55 | 0.39 | 0.43 | 0.70 | 0.93 | 0.99 | 1.00 | (94) |

Useful gains, ηmGm, W (94)m x (84)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 325.95 | 354.36 | 380.06 | 386.99 | 340.74 | 239.90 | 162.03 | 169.34 | 254.35 | 311.59 | 311.08 | 312.58 | (95) |

Monthly average external temperature from Table U1

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 645.68 | 624.31 | 565.55 | 470.12 | 361.50 | 241.86 | 162.19 | 169.64 | 262.84 | 399.12 | 530.20 | 640.78 | (97) |

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 237.88 | 181.41 | 138.01 | 59.85 | 15.45 | 0.00 | 0.00 | 0.00 | 0.00 | 65.12 | 157.77 | 244.18 |

| | | | |
|---|---|---|---|
| | ∑(98)1...5, 10...12 = | 1099.65 | (98) |
| Space heating requirement kWh/m²/year | (98) ÷ (4) | 21.85 | (99) |

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from boilers | | 1.00 | (303a) |
| Fraction of total space heat from community boilers | (302) x (303a) = | 1.00 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community space heating | | 1.00 | (305) |
| Factor for charging method (Table 4c(3)) for community water heating | | 1.00 | (305a) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |

**Space heating**

| | | | | |
|---|---|---|---|---|
| Annual space heating requirement | 1099.65 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 1154.64 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1494.66 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1569.39 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 27.24 | (313) |

| | | | |
|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| mechanical ventilation fans - balanced, extract or positive input from outside | 101.68 | | (330a) |
| Total electricity for the above, kWh/year | | 101.68 | (331) |
| Electricity for lighting (Appendix L) | | 244.38 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 3070.08 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 1154.64 | x | 4.24 | x 0.01 = | 48.96 | (340a) |
| Water heating from boilers | 1569.39 | x | 4.24 | x 0.01 = | 66.54 | (342a) |
| Pumps and fans | 101.68 | x | 13.19 | x 0.01 = | 13.41 | (349) |
| Electricity for lighting | 244.38 | x | 13.19 | x 0.01 = | 32.23 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 281.14 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.24 | (357) |
| SAP value | 82.72 | |
| SAP rating (section 13) | 83 | (358) |
| SAP band | B | |

## 12b. $CO_2$ emissions - community heating scheme

| | Energy kWh/year | | Emission factor | | Emissions (kg/year) | |
|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | |
| Efficiency of boilers | 89.50 | | | | | (367a) |
| CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) = | 3043.60 | x | 0.216 | = | 657.42 | (367) |
| Electrical energy for community heat distribution | 27.24 | x | 0.519 | = | 14.14 | (372) |
| Total CO2 associated with community systems | | | | | 671.56 | (373) |
| Total CO2 associated with space and water heating | | | | | 671.56 | (376) |
| Pumps and fans | 101.68 | x | 0.519 | = | 52.77 | (378) |
| Electricity for lighting | 244.38 | x | 0.519 | = | 126.83 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 851.16 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 16.91 | (384) |
| EI value | | | | | 88.03 | |
| EI rating (section 14) | | | | | 88 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of boilers | 89.50 | | | | | (367a) |
| Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) = | 3043.60 | x | 1.22 | = | 3713.20 | (367) |
| Electrical energy for community heat distribution | 27.24 | x | 3.07 | = | 83.63 | (372) |
| Total primary energy associated with community systems | | | | | 3796.82 | (373) |
| Total primary energy associated with space and water heating | | | | | 3796.82 | (376) |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| Pumps and fans | 101.68 | x | 3.07 | = | 312.15 | (378) |
| Electricity for lighting | 244.38 | x | 3.07 | = | 750.24 | (379) |
| Primary energy kWh/year |  |  |  |  | 4859.22 | (383) |
| Dwelling primary energy rate kWh/m2/year |  |  |  |  | 96.57 | (384) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 2B3P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 64.62 | (1a) | x | 2.50 | (2a) | = | 161.55 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 64.62 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 161.55 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

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

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.13 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.16 | 0.16 | 0.16 | 0.14 | 0.14 | 0.12 | 0.12 | 0.12 | 0.13 | 0.14 | 0.14 | 0.15 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 74.80 | (23c) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100] | 0.29 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.25 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | (24a) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.29 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.25 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, $m^2$ | Openings $m^2$ | Net area A, $m^2$ | | U-value W/$m^2$K | | A x U W/K | κ-value, kJ/$m^2$.K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 15.04 | x | 1.24 | = | 18.59 | | | (27) |
| Door | | | 1.80 | x | 0.60 | = | 1.08 | | | (26) |
| External wall | | | 31.51 | x | 0.17 | = | 5.36 | | | (29a) |
| Party wall | | | 14.88 | x | 0.00 | = | 0.00 | | | (32) |
| External wall | | | 22.05 | x | 0.20 | = | 4.41 | | | (29a) |
| Roof | | | 64.62 | x | 0.13 | = | 8.40 | | | (30) |
| Total area of external elements ∑A, $m^2$ | | | 135.02 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 37.83 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/$m^2$K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 15.57 | (36) |
| Total fabric heat loss | (33) + (36) = | 53.41 | (37) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15.38 | 15.21 | 15.04 | 14.19 | 14.02 | 13.17 | 13.17 | 13.00 | 13.51 | 14.02 | 14.36 | 14.70 | (38) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 68.79 | 68.62 | 68.45 | 67.60 | 67.43 | 66.58 | 66.58 | 66.41 | 66.92 | 67.43 | 67.77 | 68.11 | |

Average = ∑(39)1...12/12 = 67.56 (39)

Heat loss parameter (HLP), W/$m^2$K (39)m ÷ (4)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.06 | 1.06 | 1.06 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.04 | 1.04 | 1.05 | 1.05 | |

Average = ∑(40)1...12/12 = 1.05 (40)

Number of days in month (Table 1a)

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

Assumed occupancy, N 2.11 (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 84.28 (43)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 92.71 | 89.34 | 85.97 | 82.60 | 79.23 | 75.86 | 75.86 | 79.23 | 82.60 | 85.97 | 89.34 | 92.71 | |

∑(44)1...12 = 1011.41 (44)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 137.49 | 120.25 | 124.09 | 108.18 | 103.80 | 89.57 | 83.00 | 95.25 | 96.39 | 112.33 | 122.61 | 133.15 | |

∑(45)1...12 = 1326.12 (45)

Distribution loss 0.15 x (45)m

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.62 | 18.04 | 18.61 | 16.23 | 15.57 | 13.44 | 12.45 | 14.29 | 14.46 | 16.85 | 18.39 | 19.97 | (46) |

Storage volume (litres) including any solar or WWHRS storage within same vessel 3.00 (47)

Water storage loss:

b) Manufacturer's declared loss factor is not known

| | | |
|---|---|---|
| Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51) |
| Volume factor from Table 2a | 3.42 | (52) |
| Temperature factor from Table 2b | 0.60 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.13 | (54) |
| Enter (50) or (54) in (55) | 0.13 | (55) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 164.79 | 144.91 | 151.39 | 134.60 | 131.11 | 116.00 | 110.31 | 122.55 | 122.81 | 139.63 | 149.04 | 160.46 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 164.79 | 144.91 | 151.39 | 134.60 | 131.11 | 116.00 | 110.31 | 122.55 | 122.81 | 139.63 | 149.04 | 160.46 | |

∑(64)1...12 = 1647.59 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 67.56 | 59.71 | 63.10 | 57.11 | 56.36 | 50.92 | 49.44 | 53.51 | 53.19 | 59.19 | 61.91 | 66.12 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | | | | | | | | | | | | | |
| | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | 105.44 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 16.44 | 14.60 | 11.88 | 8.99 | 6.72 | 5.67 | 6.13 | 7.97 | 10.70 | 13.58 | 15.85 | 16.90 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 184.43 | 186.34 | 181.52 | 171.25 | 158.29 | 146.11 | 137.98 | 136.06 | 140.88 | 151.15 | 164.11 | 176.29 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | 33.54 | (69) |
| Pump and fan gains (Table 5a) | | | | | | | | | | | | | |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | | | | | | | | | | | | | |
| | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | -84.35 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 90.80 | 88.86 | 84.81 | 79.32 | 75.75 | 70.72 | 66.45 | 71.93 | 73.87 | 79.56 | 85.98 | 88.87 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | | | | | | | | | | | | | |
| | 346.31 | 344.44 | 332.84 | 314.20 | 295.40 | 277.14 | 265.19 | 270.59 | 280.08 | 298.93 | 320.58 | 336.69 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.77 | x | 8.20 | x | 10.63 | x 0.9 x | 0.45 | x | 0.70 | = | 19.03 | (74) |
| East | 0.77 | x | 6.84 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 29.33 | (76) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 48.36 | 93.74 | 156.29 | 237.07 | 302.61 | 316.04 | 298.24 | 247.42 | 184.19 | 111.37 | 60.05 | 39.98 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 394.67 | 438.18 | 489.13 | 551.27 | 598.00 | 593.18 | 563.44 | 518.01 | 464.28 | 410.30 | 380.63 | 376.67 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 1.00 | 0.99 | 0.96 | 0.86 | 0.68 | 0.51 | 0.58 | 0.84 | 0.98 | 1.00 | 1.00 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 19.89 | 20.01 | 20.25 | 20.57 | 20.84 | 20.97 | 20.99 | 20.99 | 20.90 | 20.55 | 20.17 | 19.86 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C) | 20.03 | 20.03 | 20.03 | 20.05 | 20.05 | 20.06 | 20.06 | 20.06 | 20.05 | 20.05 | 20.04 | 20.04 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 1.00 | 0.99 | 0.98 | 0.94 | 0.82 | 0.60 | 0.41 | 0.47 | 0.77 | 0.97 | 0.99 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 18.54 | 18.73 | 19.07 | 19.54 | 19.89 | 20.04 | 20.06 | 20.06 | 19.97 | 19.52 | 18.96 | 18.52 | (90) |

Living area fraction Living area ÷ (4) = 0.42 (91)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | 19.10 | 19.26 | 19.56 | 19.97 | 20.28 | 20.42 | 20.45 | 20.44 | 20.36 | 19.95 | 19.46 | 19.08 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 19.10 | 19.26 | 19.56 | 19.97 | 20.28 | 20.42 | 20.45 | 20.44 | 20.36 | 19.95 | 19.46 | 19.08 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 1.00 | 0.99 | 0.98 | 0.94 | 0.83 | 0.63 | 0.45 | 0.51 | 0.80 | 0.96 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 393.15 | 435.00 | 480.26 | 519.08 | 496.62 | 373.90 | 254.27 | 265.09 | 370.74 | 395.52 | 377.71 | 375.53 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1018.15 | 985.60 | 894.04 | 748.23 | 578.72 | 387.77 | 256.12 | 268.62 | 418.59 | 630.70 | 837.84 | 1013.28 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 465.01 | 370.00 | 307.86 | 164.98 | 61.08 | 0.00 | 0.00 | 0.00 | 0.00 | 174.97 | 331.30 | 474.48 | |

∑(98)1...5, 10...12 = 2349.68 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 36.36 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from boilers | | 1.00 | (303a) |
| Fraction of total space heat from community boilers | (302) x (303a) = | 1.00 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community space heating | | 1.00 | (305) |
| Factor for charging method (Table 4c(3)) for community water heating | | 1.00 | (305a) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |

**Space heating**

| | | | | |
|---|---|---|---|---|
| Annual space heating requirement | 2349.68 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 2467.16 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1647.59 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1729.97 | (310a) |

| | | | |
|---|---|---|---|
| Electricity used for heat distribution | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 41.97 | (313) |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| mechanical ventilation fans - balanced, extract or positive input from outside | 147.82 | | (330a) |
| Total electricity for the above, kWh/year | | 147.82 | (331) |
| Electricity for lighting (Appendix L) | | 290.37 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4635.33 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 2467.16 | x | 4.24 | x 0.01 = | 104.61 | (340a) |
| Water heating from boilers | 1729.97 | x | 4.24 | x 0.01 = | 73.35 | (342a) |
| Pumps and fans | 147.82 | x | 13.19 | x 0.01 = | 19.50 | (349) |
| Electricity for lighting | 290.37 | x | 13.19 | x 0.01 = | 38.30 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 355.76 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.36 | (357) |
| SAP value | 80.99 | |
| SAP rating (section 13) | 81 | (358) |
| SAP band | B | |

## 12b. CO₂ emissions - community heating scheme

| | Energy kWh/year | | Emission factor | | Emissions (kg/year) | |
|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | |
| Efficiency of boilers | 89.50 | | | | | (367a) |
| CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) = | 4689.54 | x | 0.216 | = | 1012.94 | (367) |
| Electrical energy for community heat distribution | 41.97 | x | 0.519 | = | 21.78 | (372) |
| Total CO2 associated with community systems | | | | | 1034.72 | (373) |
| Total CO2 associated with space and water heating | | | | | 1034.72 | (376) |
| Pumps and fans | 147.82 | x | 0.519 | = | 76.72 | (378) |
| Electricity for lighting | 290.37 | x | 0.519 | = | 150.70 | (379) |
| Total CO₂, kg/year | | | | (376)..(382) = | 1262.14 | (383) |
| Dwelling CO₂ emission rate | | | | (383) ÷ (4) = | 19.53 | (384) |
| EI value | | | | | 84.57 | |
| EI rating (section 14) | | | | | 85 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of boilers | 89.50 | | | | | (367a) |
| Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) = | 4689.54 | x | 1.22 | = | 5721.23 | (367) |
| Electrical energy for community heat distribution | 41.97 | x | 3.07 | = | 128.85 | (372) |
| Total primary energy associated with community systems | | | | | 5850.08 | (373) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Total primary energy associated with space and water heating | | | | | 5850.08 | (376) |
| Pumps and fans | 147.82 | x | 3.07 | = | 453.80 | (378) |
| Electricity for lighting | 290.37 | x | 3.07 | = | 891.45 | (379) |
| Primary energy kWh/year | | | | | 7195.33 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 111.35 | (384) |

# DER Worksheet
## Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco  Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 2B4P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 73.74 | (1a) | x | 2.50 | (2a) | = | 184.35 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 73.74 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 184.35 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

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

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.13 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | | | | | | | | | | | | | |
| | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | | | | | | | | | | | | | |
| | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | | | | | | | | | | | | | |
| | 0.16 | 0.16 | 0.16 | 0.14 | 0.14 | 0.12 | 0.12 | 0.12 | 0.13 | 0.14 | 0.14 | 0.15 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 75.65 | (23c) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.28 | 0.28 | 0.28 | 0.26 | 0.26 | 0.24 | 0.24 | 0.24 | 0.25 | 0.26 | 0.27 | 0.27 | (24a) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | | | | | | | | | | | | | |
| | 0.28 | 0.28 | 0.28 | 0.26 | 0.26 | 0.24 | 0.24 | 0.24 | 0.25 | 0.26 | 0.27 | 0.27 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 15.42 | x | 1.24 | = | 19.06 | | | (27) |
| Door | | | 1.80 | x | 0.70 | = | 1.26 | | | (26) |
| External wall | | | 29.58 | x | 0.17 | = | 5.03 | | | (29a) |
| Party wall | | | 15.83 | x | 0.00 | = | 0.00 | | | (32) |
| External wall | | | 29.63 | x | 0.20 | = | 5.93 | | | (29a) |
| Total area of external elements ∑A, m² | | | 76.43 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 31.27 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 9.45 | (36) |
| Total fabric heat loss | (33) + (36) = | 40.72 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 17.30 | 17.10 | 16.91 | 15.94 | 15.74 | 14.78 | 14.78 | 14.58 | 15.16 | 15.74 | 16.13 | 16.52 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 58.02 | 57.82 | 57.63 | 56.66 | 56.47 | 55.50 | 55.50 | 55.30 | 55.88 | 56.47 | 56.85 | 57.24 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 56.61 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.79 | 0.78 | 0.78 | 0.77 | 0.77 | 0.75 | 0.75 | 0.75 | 0.76 | 0.77 | 0.77 | 0.78 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.77 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.33 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.62 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 98.58 | 95.00 | 91.41 | 87.83 | 84.24 | 80.66 | 80.66 | 84.24 | 87.83 | 91.41 | 95.00 | 98.58 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1075.42 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.19 | 127.86 | 131.94 | 115.03 | 110.37 | 95.24 | 88.26 | 101.28 | 102.49 | 119.44 | 130.37 | 141.58 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1410.04 | (45) |
| Distribution loss 0.15 x (45)m | 21.93 | 19.18 | 19.79 | 17.25 | 16.56 | 14.29 | 13.24 | 15.19 | 15.37 | 17.92 | 19.56 | 21.24 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |
| Water storage loss: | | |
| b) Manufacturer's declared loss factor is not known | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51) |
| Volume factor from Table 2a | 3.42 | (52) |
| Temperature factor from Table 2b | 0.60 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.13 | (54) |
| Enter (50) or (54) in (55) | 0.13 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.49 | 152.52 | 159.24 | 141.45 | 137.68 | 121.67 | 115.56 | 128.58 | 128.91 | 146.74 | 156.80 | 168.88 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.49 | 152.52 | 159.24 | 141.45 | 137.68 | 121.67 | 115.56 | 128.58 | 128.91 | 146.74 | 156.80 | 168.88 |

∑(64)1...12 = 1731.52 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.45 | 62.24 | 65.71 | 59.39 | 58.54 | 52.81 | 51.19 | 55.52 | 55.21 | 61.56 | 64.49 | 68.92 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | | | | | | | | | | | | | |
| | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | 116.67 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 18.41 | 16.35 | 13.30 | 10.07 | 7.53 | 6.35 | 6.86 | 8.92 | 11.98 | 15.21 | 17.75 | 18.92 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 205.86 | 208.00 | 202.62 | 191.16 | 176.69 | 163.09 | 154.01 | 151.87 | 157.26 | 168.72 | 183.18 | 196.78 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | 34.67 | (69) |
| Pump and fan gains (Table 5a) | | | | | | | | | | | | | |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | | | | | | | | | | | | | |
| | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | -93.34 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 94.69 | 92.62 | 88.32 | 82.48 | 78.69 | 73.34 | 68.80 | 74.62 | 76.69 | 82.74 | 89.57 | 92.63 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | | | | | | | | | | | | | |
| | 376.97 | 374.97 | 362.24 | 341.70 | 320.90 | 300.79 | 287.68 | 293.42 | 303.92 | 324.66 | 348.50 | 366.33 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.77 | x | 10.90 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 46.73 | (76) |
| South | 0.77 | x | 2.22 | x | 46.75 | x 0.9 x | 0.45 | x | 0.70 | = | 22.66 | (78) |
| West | 0.77 | x | 2.30 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 9.86 | (80) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 79.25 | 147.81 | 229.59 | 319.33 | 381.54 | 387.17 | 369.94 | 323.64 | 261.42 | 171.39 | 97.42 | 66.12 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 456.22 | 522.79 | 591.83 | 661.03 | 702.45 | 687.96 | 657.61 | 617.06 | 565.34 | 496.05 | 445.92 | 432.45 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 0.99 | 0.97 | 0.89 | 0.72 | 0.51 | 0.37 | 0.41 | 0.67 | 0.94 | 0.99 | 1.00 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 20.30 | 20.44 | 20.64 | 20.87 | 20.97 | 21.00 | 21.00 | 21.00 | 20.99 | 20.83 | 20.52 | 20.28 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C) | 20.26 | 20.27 | 20.27 | 20.28 | 20.28 | 20.29 | 20.29 | 20.30 | 20.29 | 20.28 | 20.28 | 20.27 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 1.00 | 0.99 | 0.96 | 0.86 | 0.67 | 0.46 | 0.31 | 0.35 | 0.60 | 0.91 | 0.99 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 19.32 | 19.52 | 19.82 | 20.13 | 20.26 | 20.29 | 20.29 | 20.30 | 20.28 | 20.10 | 19.66 | 19.30 | (90) |

Living area fraction — Living area ÷ (4) = 0.41 (91)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | 19.72 | 19.90 | 20.16 | 20.43 | 20.55 | 20.58 | 20.58 | 20.58 | 20.57 | 20.40 | 20.01 | 19.69 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 19.72 | 19.90 | 20.16 | 20.43 | 20.55 | 20.58 | 20.58 | 20.58 | 20.57 | 20.40 | 20.01 | 19.69 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 1.00 | 0.99 | 0.96 | 0.87 | 0.69 | 0.48 | 0.34 | 0.37 | 0.63 | 0.92 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 454.04 | 516.36 | 569.05 | 575.27 | 485.76 | 330.94 | 220.90 | 231.19 | 355.95 | 455.33 | 440.49 | 430.96 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 894.62 | 867.13 | 787.03 | 653.42 | 499.76 | 331.87 | 220.96 | 231.32 | 361.53 | 553.11 | 734.12 | 886.92 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 327.79 | 235.72 | 162.18 | 56.27 | 10.42 | 0.00 | 0.00 | 0.00 | 0.00 | 72.75 | 211.41 | 339.24 | |

| | | | |
|---|---|---|---|
| | ∑(98)1...5, 10...12 = | 1415.77 | (98) |
| Space heating requirement kWh/m²/year | (98) ÷ (4) | 19.20 | (99) |

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from boilers | | 1.00 | (303a) |
| Fraction of total space heat from community boilers | (302) x (303a) = | 1.00 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community space heating | | 1.00 | (305) |
| Factor for charging method (Table 4c(3)) for community water heating | | 1.00 | (305a) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |

**Space heating**

| | | | | |
|---|---|---|---|---|
| Annual space heating requirement | 1415.77 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 1486.56 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1731.52 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1818.10 | (310a) |

| | | | |
|---|---|---|---|
| Electricity used for heat distribution | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 33.05 | (313) |

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

| | | | |
|---|---|---|---|
| mechanical ventilation fans - balanced, extract or positive input from outside | 149.00 | | (330a) |
| Total electricity for the above, kWh/year | | 149.00 | (331) |
| Electricity for lighting (Appendix L) | | 325.11 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 3778.76 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 1486.56 | x | 4.24 | x 0.01 = | 63.03 | (340a) |
| Water heating from boilers | 1818.10 | x | 4.24 | x 0.01 = | 77.09 | (342a) |
| Pumps and fans | 149.00 | x | 13.19 | x 0.01 = | 19.65 | (349) |
| Electricity for lighting | 325.11 | x | 13.19 | x 0.01 = | 42.88 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 322.65 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.14 | (357) |
| SAP value | 84.08 | |
| SAP rating (section 13) | 84 | (358) |
| SAP band | B | |

## 12b. $CO_2$ emissions - community heating scheme

| | | Energy kWh/year | | Emission factor | | Emissions (kg/year) | |
|---|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| CO2 emissions from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 3692.35 | x | 0.216 | = | 797.55 | (367) |
| Electrical energy for community heat distribution | | 33.05 | x | 0.519 | = | 17.15 | (372) |
| Total CO2 associated with community systems | | | | | | 814.70 | (373) |
| Total CO2 associated with space and water heating | | | | | | 814.70 | (376) |
| Pumps and fans | | 149.00 | x | 0.519 | = | 77.33 | (378) |
| Electricity for lighting | | 325.11 | x | 0.519 | = | 168.73 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 1060.76 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 14.39 | (384) |
| EI value | | | | | | 88.03 | |
| EI rating (section 14) | | | | | | 88 | (385) |
| EI band | | | | | | B | |

## 13b. Primary energy - community heating scheme

| | | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| Primary energy from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 3692.35 | x | 1.22 | = | 4504.67 | (367) |
| Electrical energy for community heat distribution | | 33.05 | x | 3.07 | = | 101.45 | (372) |
| Total primary energy associated with community systems | | | | | | 4606.12 | (373) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Total primary energy associated with space and water heating | | | | | 4606.12 | (376) |
| Pumps and fans | 149.00 | x | 3.07 | = | 457.43 | (378) |
| Electricity for lighting | 325.11 | x | 3.07 | = | 998.08 | (379) |
| Primary energy kWh/year | | | | | 6061.63 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 82.20 | (384) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco  Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 2B3P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.00 | (1a) | x | 2.50 | (2a) | = | 185.00 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.00 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 185.00 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

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

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.13 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.16 | 0.16 | 0.16 | 0.14 | 0.14 | 0.12 | 0.12 | 0.12 | 0.13 | 0.14 | 0.14 | 0.15 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 74.80 | (23c) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100] | 0.29 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.25 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | (24a) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.29 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.25 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 17.96 | x | 1.24 | = | 22.19 | | | (27) |
| Door | | | 1.80 | x | 0.70 | = | 1.26 | | | (26) |
| External wall | | | 30.44 | x | 0.17 | = | 5.17 | | | (29a) |
| Party wall | | | 32.15 | x | 0.00 | = | 0.00 | | | (32) |
| External wall | | | 2.65 | x | 0.20 | = | 0.53 | | | (29a) |
| Total area of external elements ∑A, m² | | | 52.85 | | | | | | | (31) |

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 29.16 (33)

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

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

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 7.34 (36)

Total fabric heat loss (33) + (36) = 36.49 (37)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 17.62 | 17.42 | 17.23 | 16.25 | 16.06 | 15.09 | 15.09 | 14.89 | 15.48 | 16.06 | 16.45 | 16.84 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 54.11 | 53.92 | 53.72 | 52.75 | 52.55 | 51.58 | 51.58 | 51.39 | 51.97 | 52.55 | 52.94 | 53.33 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 52.70 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.73 | 0.73 | 0.73 | 0.71 | 0.71 | 0.70 | 0.70 | 0.69 | 0.70 | 0.71 | 0.72 | 0.72 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.71 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

Assumed occupancy, N 2.34 (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 89.76 (43)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 98.73 | 95.14 | 91.55 | 87.96 | 84.37 | 80.78 | 80.78 | 84.37 | 87.96 | 91.55 | 95.14 | 98.73 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1077.07 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.42 | 128.06 | 132.14 | 115.21 | 110.54 | 95.39 | 88.39 | 101.43 | 102.64 | 119.62 | 130.57 | 141.80 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1412.21 | (45) |
| Distribution loss 0.15 x (45)m | 21.96 | 19.21 | 19.82 | 17.28 | 16.58 | 14.31 | 13.26 | 15.21 | 15.40 | 17.94 | 19.59 | 21.27 | (46) |

Storage volume (litres) including any solar or WWHRS storage within same vessel 3.00 (47)

Water storage loss:

b) Manufacturer's declared loss factor is not known

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.02 (51)

Volume factor from Table 2a 3.42 (52)

Temperature factor from Table 2b 0.60 (53)

Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) 0.13 (54)

Enter (50) or (54) in (55) 0.13 (55)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.72 | 152.72 | 159.45 | 141.63 | 137.85 | 121.81 | 115.70 | 128.74 | 129.07 | 146.92 | 157.00 | 169.10 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.72 | 152.72 | 159.45 | 141.63 | 137.85 | 121.81 | 115.70 | 128.74 | 129.07 | 146.92 | 157.00 | 169.10 |

∑(64)1...12 = 1733.69 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.53 | 62.31 | 65.78 | 59.44 | 58.60 | 52.86 | 51.23 | 55.57 | 55.27 | 61.62 | 64.55 | 68.99 | (65) |

## 5. Internal gains

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

Metabolic gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | 116.96 | (66) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.40 | 16.35 | 13.29 | 10.06 | 7.52 | 6.35 | 6.86 | 8.92 | 11.97 | 15.20 | 17.74 | 18.92 | (67) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 206.45 | 208.59 | 203.19 | 191.70 | 177.19 | 163.56 | 154.45 | 152.30 | 157.70 | 169.20 | 183.70 | 197.34 | (68) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | 34.70 | (69) |

Pump and fan gains (Table 5a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |

Losses e.g. evaporation (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | -93.57 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 94.79 | 92.72 | 88.41 | 82.56 | 78.76 | 73.41 | 68.86 | 74.69 | 76.76 | 82.82 | 89.66 | 92.73 | (72) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 377.73 | 375.74 | 362.99 | 342.41 | 321.56 | 301.41 | 288.26 | 294.00 | 304.52 | 325.31 | 349.19 | 367.07 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.77 | x | 6.10 | x | 10.63 | x 0.9 x | 0.45 | x | 0.70 | = | 14.16 | (74) |
| NorthEast | 0.77 | x | 3.20 | x | 11.28 | x 0.9 x | 0.45 | x | 0.70 | = | 7.88 | (75) |
| West | 0.77 | x | 8.66 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 37.13 | (80) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 59.17 | 115.73 | 194.50 | 295.78 | 377.09 | 393.39 | 371.44 | 308.60 | 229.62 | 138.00 | 73.68 | 48.77 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 436.90 | 491.48 | 557.49 | 638.19 | 698.66 | 694.80 | 659.70 | 602.61 | 534.14 | 463.31 | 422.87 | 415.84 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 0.99 | 0.97 | 0.88 | 0.68 | 0.47 | 0.34 | 0.39 | 0.66 | 0.94 | 0.99 | 1.00 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 20.36 | 20.48 | 20.68 | 20.90 | 20.99 | 21.00 | 21.00 | 21.00 | 20.99 | 20.85 | 20.56 | 20.34 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C) | 20.31 | 20.32 | 20.32 | 20.33 | 20.33 | 20.34 | 20.34 | 20.35 | 20.34 | 20.33 | 20.33 | 20.32 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 1.00 | 0.99 | 0.97 | 0.86 | 0.64 | 0.43 | 0.29 | 0.34 | 0.60 | 0.92 | 0.99 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 19.45 | 19.62 | 19.91 | 20.21 | 20.32 | 20.34 | 20.34 | 20.35 | 20.33 | 20.16 | 19.76 | 19.43 | (90) |

Living area fraction Living area ÷ (4) = 0.48 (91)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | 19.89 | 20.04 | 20.28 | 20.54 | 20.64 | 20.66 | 20.66 | 20.66 | 20.65 | 20.49 | 20.15 | 19.87 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 19.89 | 20.04 | 20.28 | 20.54 | 20.64 | 20.66 | 20.66 | 20.66 | 20.65 | 20.49 | 20.15 | 19.87 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 1.00 | 0.99 | 0.97 | 0.86 | 0.66 | 0.45 | 0.32 | 0.36 | 0.63 | 0.93 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 435.20 | 486.72 | 538.75 | 551.86 | 461.84 | 312.23 | 209.46 | 218.96 | 336.37 | 429.41 | 418.62 | 414.67 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 843.43 | 816.12 | 740.27 | 614.24 | 469.92 | 312.61 | 209.48 | 219.02 | 340.50 | 519.94 | 690.86 | 835.56 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 303.72 | 221.36 | 149.93 | 44.92 | 6.01 | 0.00 | 0.00 | 0.00 | 0.00 | 67.35 | 196.02 | 313.15 | |

∑(98)1...5, 10...12 = 1302.45 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 17.60 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from boilers | | 1.00 | (303a) |
| Fraction of total space heat from community boilers | (302) x (303a) = | 1.00 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community space heating | | 1.00 | (305) |
| Factor for charging method (Table 4c(3)) for community water heating | | 1.00 | (305a) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |

**Space heating**

Annual space heating requirement 1302.45 (98)

Space heat from boilers (98) x (304a) x (305) x (306) = 1367.57 (307a)

**Water heating**

Annual water heating requirement 1733.69 (64)

Water heat from boilers (64) x (303a) x (305a) x (306) = 1820.37 (310a)

Electricity used for heat distribution 0.01 × [(307a)...(307e) + (310a)...(310e)] = 31.88 (313)

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

mechanical ventilation fans - balanced, extract or positive input from outside 169.28 (330a)

Total electricity for the above, kWh/year 169.28 (331)

Electricity for lighting (Appendix L) 325.04 (332)

Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = 3682.26 (338)

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 1367.57 | x | 4.24 | x 0.01 = | 57.99 | (340a) |
| Water heating from boilers | 1820.37 | x | 4.24 | x 0.01 = | 77.18 | (342a) |
| Pumps and fans | 169.28 | x | 13.19 | x 0.01 = | 22.33 | (349) |
| Electricity for lighting | 325.04 | x | 13.19 | x 0.01 = | 42.87 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 320.37 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.13 | (357) |
| SAP value | 84.23 | |
| SAP rating (section 13) | 84 | (358) |
| SAP band | B | |

## 12b. CO₂ emissions - community heating scheme

| | Energy kWh/year | | Emission factor | | Emissions (kg/year) | |
|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | |
| Efficiency of boilers | 89.50 | | | | | (367a) |
| CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) = | 3561.95 | x | 0.216 | = | 769.38 | (367) |
| Electrical energy for community heat distribution | 31.88 | x | 0.519 | = | 16.55 | (372) |
| Total CO2 associated with community systems | | | | | 785.93 | (373) |
| Total CO2 associated with space and water heating | | | | | 785.93 | (376) |
| Pumps and fans | 169.28 | x | 0.519 | = | 87.85 | (378) |
| Electricity for lighting | 325.04 | x | 0.519 | = | 168.69 | (379) |
| Total CO₂, kg/year | | | (376)..(382) = | | 1042.47 | (383) |
| Dwelling CO₂ emission rate | | | (383) ÷ (4) = | | 14.09 | (384) |
| EI value | | | | | 88.26 | |
| EI rating (section 14) | | | | | 88 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of boilers | 89.50 | | | | | (367a) |
| Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) = | 3561.95 | x | 1.22 | = | 4345.58 | (367) |
| Electrical energy for community heat distribution | 31.88 | x | 3.07 | = | 97.87 | (372) |
| Total primary energy associated with community systems | | | | | 4443.45 | (373) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Total primary energy associated with space and water heating | | | | | 4443.45 | (376) |
| Pumps and fans | 169.28 | x | 3.07 | = | 519.67 | (378) |
| Electricity for lighting | 325.04 | x | 3.07 | = | 997.86 | (379) |
| Primary energy kWh/year | | | | | 5960.98 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 80.55 | (384) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco  Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 3B4P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 72.42 | (1a) | x | 2.50 | (2a) | = | 181.05 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 72.42 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 181.05 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

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

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.13 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.16 | 0.16 | 0.16 | 0.14 | 0.14 | 0.12 | 0.12 | 0.12 | 0.13 | 0.14 | 0.14 | 0.15 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 75.65 | (23c) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100] | 0.28 | 0.28 | 0.28 | 0.26 | 0.26 | 0.24 | 0.24 | 0.24 | 0.25 | 0.26 | 0.27 | 0.27 | (24a) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.28 | 0.28 | 0.28 | 0.26 | 0.26 | 0.24 | 0.24 | 0.24 | 0.25 | 0.26 | 0.27 | 0.27 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 15.02 | x | 1.24 | = | 18.56 | | | (27) |
| Door | | | 1.80 | x | 0.70 | = | 1.26 | | | (26) |
| External wall | | | 30.08 | x | 0.17 | = | 5.11 | | | (29a) |
| Party wall | | | 32.93 | x | 0.00 | = | 0.00 | | | (32) |
| External wall | | | 10.38 | x | 0.20 | = | 2.08 | | | (29a) |
| Roof | | | 72.42 | x | 0.13 | = | 9.41 | | | (30) |
| Total area of external elements ∑A, m² | | | 129.70 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 36.43 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 12.44 | (36) |
| Total fabric heat loss | (33) + (36) = | 48.87 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 16.99 | 16.80 | 16.61 | 15.65 | 15.46 | 14.51 | 14.51 | 14.32 | 14.89 | 15.46 | 15.84 | 16.22 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 65.85 | 65.66 | 65.47 | 64.52 | 64.33 | 63.38 | 63.38 | 63.19 | 63.76 | 64.33 | 64.71 | 65.09 | |

Average = ∑(39)1...12/12 = 64.47 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.91 | 0.91 | 0.90 | 0.89 | 0.89 | 0.88 | 0.88 | 0.87 | 0.88 | 0.89 | 0.89 | 0.90 | |

Average = ∑(40)1...12/12 = 0.89 (40)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.30 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 88.91 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 97.80 | 94.24 | 90.68 | 87.13 | 83.57 | 80.02 | 80.02 | 83.57 | 87.13 | 90.68 | 94.24 | 97.80 | |

∑(44)1...12 = 1066.87 (44)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 145.03 | 126.84 | 130.89 | 114.11 | 109.50 | 94.49 | 87.56 | 100.47 | 101.67 | 118.49 | 129.34 | 140.45 | |

∑(45)1...12 = 1398.84 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 21.75 | 19.03 | 19.63 | 17.12 | 16.42 | 14.17 | 13.13 | 15.07 | 15.25 | 17.77 | 19.40 | 21.07 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |

Water storage loss:

b) Manufacturer's declared loss factor is not known

| | | |
|---|---|---|
| Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51) |
| Volume factor from Table 2a | 3.42 | (52) |
| Temperature factor from Table 2b | 0.60 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.13 | (54) |
| Enter (50) or (54) in (55) | 0.13 | (55) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.33 | 151.51 | 158.20 | 140.54 | 136.80 | 120.91 | 114.86 | 127.77 | 128.09 | 145.79 | 155.76 | 167.76 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.33 | 151.51 | 158.20 | 140.54 | 136.80 | 120.91 | 114.86 | 127.77 | 128.09 | 145.79 | 155.76 | 167.76 | |

∑(64)1...12 = 1720.32 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.07 | 61.90 | 65.36 | 59.08 | 58.25 | 52.55 | 50.96 | 55.25 | 54.94 | 61.24 | 64.14 | 68.54 | (65) |

## 5. Internal gains

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

Metabolic gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | 115.17 | (66) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.15 | 16.12 | 13.11 | 9.93 | 7.42 | 6.26 | 6.77 | 8.80 | 11.81 | 15.00 | 17.50 | 18.66 | (67) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 202.88 | 204.98 | 199.68 | 188.38 | 174.13 | 160.73 | 151.78 | 149.67 | 154.98 | 166.27 | 180.53 | 193.93 | (68) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | 34.52 | (69) |

Pump and fan gains (Table 5a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |

Losses e.g. evaporation (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | -92.14 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 94.17 | 92.12 | 87.86 | 82.06 | 78.29 | 72.99 | 68.49 | 74.26 | 76.31 | 82.31 | 89.09 | 92.13 | (72) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 372.76 | 370.78 | 358.20 | 337.92 | 317.39 | 297.54 | 284.59 | 290.28 | 300.65 | 321.13 | 344.67 | 362.26 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.77 | x | 10.54 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 45.19 | (80) |
| South | 0.77 | x | 4.48 | x | 46.75 | x 0.9 x | 0.45 | x | 0.70 | = | 45.72 | (78) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 90.91 | 163.28 | 240.97 | 320.13 | 372.55 | 374.48 | 359.22 | 320.42 | 268.96 | 185.66 | 110.54 | 76.67 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 463.67 | 534.06 | 599.16 | 658.05 | 689.94 | 672.02 | 643.81 | 610.70 | 569.61 | 506.79 | 455.21 | 438.93 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 0.99 | 0.98 | 0.92 | 0.79 | 0.59 | 0.43 | 0.47 | 0.73 | 0.95 | 0.99 | 1.00 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 20.14 | 20.28 | 20.51 | 20.76 | 20.93 | 20.99 | 21.00 | 21.00 | 20.97 | 20.74 | 20.39 | 20.11 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C) | 20.16 | 20.16 | 20.16 | 20.18 | 20.18 | 20.19 | 20.19 | 20.19 | 20.18 | 20.18 | 20.17 | 20.17 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 1.00 | 0.99 | 0.97 | 0.90 | 0.74 | 0.52 | 0.35 | 0.39 | 0.66 | 0.93 | 0.99 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 19.00 | 19.22 | 19.54 | 19.91 | 20.11 | 20.18 | 20.19 | 20.19 | 20.16 | 19.89 | 19.39 | 18.97 | (90) |

Living area fraction Living area ÷ (4) = 0.38 (91)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | 19.43 | 19.62 | 19.90 | 20.23 | 20.42 | 20.49 | 20.49 | 20.49 | 20.46 | 20.21 | 19.76 | 19.40 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 19.43 | 19.62 | 19.90 | 20.23 | 20.42 | 20.49 | 20.49 | 20.49 | 20.46 | 20.21 | 19.76 | 19.40 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.99 | 0.97 | 0.90 | 0.76 | 0.55 | 0.38 | 0.42 | 0.69 | 0.93 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 461.31 | 527.58 | 579.47 | 593.51 | 523.53 | 368.87 | 246.32 | 257.97 | 390.45 | 471.88 | 449.78 | 437.28 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 996.17 | 966.53 | 877.50 | 730.87 | 560.91 | 373.02 | 246.69 | 258.64 | 405.71 | 618.19 | 819.39 | 989.23 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 397.94 | 294.98 | 221.73 | 98.90 | 27.82 | 0.00 | 0.00 | 0.00 | 0.00 | 108.86 | 266.12 | 410.65 | |

∑(98)1...5, 10...12 = 1827.00 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 25.23 (99)

## 9b. Energy requirements - community heating scheme

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

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

Fraction of community heat from boilers 1.00 (303a)

Fraction of total space heat from community boilers (302) x (303a) = 1.00 (304a)

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

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

Distribution loss factor (Table 12c) for community heating system 1.05 (306)

**Space heating**

Annual space heating requirement 1827.00 (98)

Space heat from boilers (98) x (304a) x (305) x (306) = 1918.35 (307a)

**Water heating**

Annual water heating requirement 1720.32 (64)

Water heat from boilers (64) x (303a) x (305a) x (306) = 1806.33 (310a)

| | | | |
|---|---|---|---|
| Electricity used for heat distribution | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 37.25 | (313) |

| | | | |
|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| mechanical ventilation fans - balanced, extract or positive input from outside | 146.33 | | (330a) |
| Total electricity for the above, kWh/year | | 146.33 | (331) |
| Electricity for lighting (Appendix L) | | 320.59 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4191.61 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 1918.35 | x | 4.24 | x 0.01 = | 81.34 | (340a) |
| Water heating from boilers | 1806.33 | x | 4.24 | x 0.01 = | 76.59 | (342a) |
| Pumps and fans | 146.33 | x | 13.19 | x 0.01 = | 19.30 | (349) |
| Electricity for lighting | 320.59 | x | 13.19 | x 0.01 = | 42.29 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 339.51 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.21 | (357) |
| SAP value | 83.06 | |
| SAP rating (section 13) | 83 | (358) |
| SAP band | B | |

## 12b. CO₂ emissions - community heating scheme

| | | Energy kWh/year | | Emission factor | | Emissions (kg/year) | |
|---|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| CO2 emissions from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 4161.65 | x | 0.216 | = | 898.92 | (367) |
| Electrical energy for community heat distribution | | 37.25 | x | 0.519 | = | 19.33 | (372) |
| Total CO2 associated with community systems | | | | | | 918.25 | (373) |
| Total CO2 associated with space and water heating | | | | | | 918.25 | (376) |
| Pumps and fans | | 146.33 | x | 0.519 | = | 75.95 | (378) |
| Electricity for lighting | | 320.59 | x | 0.519 | = | 166.39 | (379) |
| Total CO₂, kg/year | | | | | (376)..(382) = | 1160.58 | (383) |
| Dwelling CO₂ emission rate | | | | | (383) ÷ (4) = | 16.03 | (384) |
| EI value | | | | | | 86.76 | |
| EI rating (section 14) | | | | | | 87 | (385) |
| EI band | | | | | | B | |

## 13b. Primary energy - community heating scheme

| | | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| Primary energy from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 4161.65 | x | 1.22 | = | 5077.22 | (367) |
| Electrical energy for community heat distribution | | 37.25 | x | 3.07 | = | 114.35 | (372) |
| Total primary energy associated with community systems | | | | | | 5191.56 | (373) |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| Total primary energy associated with space and water heating |  |  |  |  | 5191.56 | (376) |
| Pumps and fans | 146.33 | x | 3.07 | = | 449.24 | (378) |
| Electricity for lighting | 320.59 | x | 3.07 | = | 984.22 | (379) |
| Primary energy kWh/year |  |  |  |  | 6625.03 | (383) |
| Dwelling primary energy rate kWh/m2/year |  |  |  |  | 91.48 | (384) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 3B5P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 104.07 | (1a) | x | 2.50 | (2a) | = | 260.18 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 104.07 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 260.18 | (5) |

## 2. Ventilation rate

| | | | | m³ per hour | |
|---|---|---|---|---|---|
| Number of chimneys | | 0 | x 40 = | 0 | (6a) |
| Number of open flues | | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | 0 | x 40 = | 0 | (7c) |
| | | | | Air changes per hour | |
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 0 | ÷ (5) = | 0.00 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.13 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.16 | 0.16 | 0.16 | 0.14 | 0.14 | 0.12 | 0.12 | 0.12 | 0.13 | 0.14 | 0.14 | 0.15 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 74.80 | (23c) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100] | 0.29 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.25 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | (24a) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.29 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.25 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 18.08 | x | 1.24 | = | 22.34 | | | (27) |
| Door | | | 1.80 | x | 1.30 | = | 2.34 | | | (26) |
| Ground floor | | | 104.07 | x | 0.10 | = | 10.41 | | | (28a) |
| External wall | | | 38.90 | x | 0.17 | = | 6.61 | | | (29a) |
| Party wall | | | 24.13 | x | 0.00 | = | 0.00 | | | (32) |
| External wall | | | 26.50 | x | 0.20 | = | 5.30 | | | (29a) |
| Total area of external elements ∑A, m² | | | 189.35 | | | | | | | (31) |

Fabric heat loss, W/K = ∑(A × U) (26)...(30) + (32) = 47.00 (33)

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

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

Thermal bridges: ∑(L x Ψ) calculated using Appendix K 13.64 (36)

Total fabric heat loss (33) + (36) = 60.64 (37)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 24.78 | 24.50 | 24.23 | 22.86 | 22.59 | 21.22 | 21.22 | 20.94 | 21.76 | 22.59 | 23.13 | 23.68 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 85.42 | 85.14 | 84.87 | 83.50 | 83.23 | 81.86 | 81.86 | 81.58 | 82.41 | 83.23 | 83.77 | 84.32 | |

Average = ∑(39)1...12/12 = 83.43 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.82 | 0.82 | 0.82 | 0.80 | 0.80 | 0.79 | 0.79 | 0.78 | 0.79 | 0.80 | 0.80 | 0.81 | |

Average = ∑(40)1...12/12 = 0.80 (40)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

Assumed occupancy, N 2.77 (42)

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 100.09 (43)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 110.09 | 106.09 | 102.09 | 98.08 | 94.08 | 90.08 | 90.08 | 94.08 | 98.08 | 102.09 | 106.09 | 110.09 | |

∑(44)1...12 = 1201.03 (44)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 163.27 | 142.79 | 147.35 | 128.46 | 123.26 | 106.37 | 98.57 | 113.11 | 114.46 | 133.39 | 145.60 | 158.12 | |

∑(45)1...12 = 1574.74 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 24.49 | 21.42 | 22.10 | 19.27 | 18.49 | 15.96 | 14.78 | 16.97 | 17.17 | 20.01 | 21.84 | 23.72 | (46) |

Storage volume (litres) including any solar or WWHRS storage within same vessel 3.00 (47)

Water storage loss:

b) Manufacturer's declared loss factor is not known

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.02 (51)

Volume factor from Table 2a 3.42 (52)

Temperature factor from Table 2b 0.60 (53)

Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) 0.13 (54)

Enter (50) or (54) in (55) 0.13 (55)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 190.57 | 167.46 | 174.65 | 154.89 | 150.57 | 132.79 | 125.87 | 140.41 | 140.88 | 160.69 | 172.03 | 185.42 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 190.57 | 167.46 | 174.65 | 154.89 | 150.57 | 132.79 | 125.87 | 140.41 | 140.88 | 160.69 | 172.03 | 185.42 | |

∑(64)1...12 = 1896.22 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 76.13 | 67.21 | 70.84 | 63.85 | 62.83 | 56.51 | 54.62 | 59.45 | 59.19 | 66.19 | 69.55 | 74.42 | (65) |

## 5. Internal gains

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

Metabolic gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | 138.71 | (66) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 24.07 | 21.38 | 17.38 | 13.16 | 9.84 | 8.31 | 8.97 | 11.66 | 15.66 | 19.88 | 23.20 | 24.73 | (67) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 262.74 | 265.47 | 258.60 | 243.97 | 225.51 | 208.16 | 196.56 | 193.84 | 200.71 | 215.33 | 233.80 | 251.15 | (68) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | 36.87 | (69) |

Pump and fan gains (Table 5a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |

Losses e.g. evaporation (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | -110.97 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 102.32 | 100.01 | 95.21 | 88.68 | 84.45 | 78.48 | 73.41 | 79.91 | 82.22 | 88.97 | 96.60 | 100.02 | (72) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 453.75 | 451.47 | 435.81 | 410.43 | 384.41 | 359.55 | 343.56 | 350.02 | 363.19 | 388.80 | 418.21 | 440.52 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.77 | x | 6.86 | x | 10.63 | x 0.9 x | 0.45 | x | 0.70 | = | 15.92 | (74) |
| NorthEast | 0.77 | x | 2.18 | x | 11.28 | x 0.9 x | 0.45 | x | 0.70 | = | 5.37 | (75) |
| East | 0.77 | x | 6.78 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 29.07 | (76) |
| SouthEast | 0.77 | x | 2.26 | x | 36.79 | x 0.9 x | 0.45 | x | 0.70 | = | 18.15 | (77) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 68.51 | 129.14 | 207.35 | 304.39 | 381.45 | 395.76 | 374.51 | 314.91 | 240.89 | 151.23 | 84.39 | 57.10 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 522.26 | 580.61 | 643.16 | 714.82 | 765.86 | 755.31 | 718.06 | 664.93 | 604.08 | 540.02 | 502.60 | 497.62 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 1.00 | 0.99 | 0.97 | 0.88 | 0.68 | 0.50 | 0.56 | 0.84 | 0.98 | 1.00 | 1.00 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 20.13 | 20.24 | 20.43 | 20.69 | 20.90 | 20.99 | 21.00 | 21.00 | 20.94 | 20.68 | 20.36 | 20.12 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C) | 20.24 | 20.24 | 20.24 | 20.25 | 20.25 | 20.26 | 20.26 | 20.27 | 20.26 | 20.25 | 20.25 | 20.24 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 1.00 | 1.00 | 0.99 | 0.96 | 0.84 | 0.61 | 0.42 | 0.47 | 0.79 | 0.98 | 1.00 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 19.06 | 19.22 | 19.50 | 19.88 | 20.15 | 20.26 | 20.26 | 20.27 | 20.21 | 19.86 | 19.40 | 19.04 | (90) |

Living area fraction Living area ÷ (4) = 0.32 (91)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | 19.40 | 19.54 | 19.80 | 20.14 | 20.39 | 20.49 | 20.50 | 20.50 | 20.45 | 20.12 | 19.71 | 19.38 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 19.40 | 19.54 | 19.80 | 20.14 | 20.39 | 20.49 | 20.50 | 20.50 | 20.45 | 20.12 | 19.71 | 19.38 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 1.00 | 1.00 | 0.99 | 0.96 | 0.85 | 0.63 | 0.44 | 0.50 | 0.80 | 0.98 | 1.00 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 521.49 | 578.70 | 636.59 | 684.18 | 647.54 | 473.96 | 318.52 | 333.02 | 484.39 | 526.64 | 500.84 | 497.08 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1289.74 | 1246.75 | 1128.37 | 938.66 | 723.49 | 482.13 | 319.18 | 334.48 | 523.04 | 792.69 | 1056.33 | 1280.28 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 571.57 | 448.93 | 365.88 | 183.23 | 56.51 | 0.00 | 0.00 | 0.00 | 0.00 | 197.94 | 399.95 | 582.70 | |

∑(98)1...5, 10...12 = 2806.71 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 26.97 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from boilers | | 1.00 | (303a) |
| Fraction of total space heat from community boilers | (302) x (303a) = | 1.00 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community space heating | | 1.00 | (305) |
| Factor for charging method (Table 4c(3)) for community water heating | | 1.00 | (305a) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |

**Space heating**

| | | | |
|---|---|---|---|
| Annual space heating requirement | 2806.71 | | (98) |
| Space heat from boilers | (98) x (304a) x (305) x (306) = | 2947.05 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | | 1896.22 | | (64) |
| Water heat from boilers | (64) x (303a) x (305a) x (306) = | | 1991.03 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | | 49.38 | (313) |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | |
| mechanical ventilation fans - balanced, extract or positive input from outside | | 238.06 | | (330a) |
| Total electricity for the above, kWh/year | | | 238.06 | (331) |
| Electricity for lighting (Appendix L) | | | 425.01 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | | 5601.15 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 2947.05 | x | 4.24 | x 0.01 = | 124.95 | (340a) |
| Water heating from boilers | 1991.03 | x | 4.24 | x 0.01 = | 84.42 | (342a) |
| Pumps and fans | 238.06 | x | 13.19 | x 0.01 = | 31.40 | (349) |
| Electricity for lighting | 425.01 | x | 13.19 | x 0.01 = | 56.06 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 416.83 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.17 | (357) |
| SAP value | 83.62 | |
| SAP rating (section 13) | 84 | (358) |
| SAP band | B | |

## 12b. CO₂ emissions - community heating scheme

| | | Energy kWh/year | | Emission factor | | Emissions (kg/year) | |
|---|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| CO2 emissions from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 5517.40 | x | 0.216 | = | 1191.76 | (367) |
| Electrical energy for community heat distribution | | 49.38 | x | 0.519 | = | 25.63 | (372) |
| Total CO2 associated with community systems | | | | | | 1217.39 | (373) |
| Total CO2 associated with space and water heating | | | | | | 1217.39 | (376) |
| Pumps and fans | | 238.06 | x | 0.519 | = | 123.55 | (378) |
| Electricity for lighting | | 425.01 | x | 0.519 | = | 220.58 | (379) |
| Total CO₂, kg/year | | | | (376)..(382) = | | 1561.52 | (383) |
| Dwelling CO₂ emission rate | | | | (383) ÷ (4) = | | 15.00 | (384) |
| EI value | | | | | | 85.96 | |
| EI rating (section 14) | | | | | | 86 | (385) |
| EI band | | | | | | B | |

## 13b. Primary energy - community heating scheme

| | | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| Primary energy from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 5517.40 | x | 1.22 | = | 6731.23 | (367) |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| Electrical energy for community heat distribution | 49.38 | x | 3.07 | = | 151.60 | (372) |
| Total primary energy associated with community systems |  |  |  |  | 6882.83 | (373) |
| Total primary energy associated with space and water heating |  |  |  |  | 6882.83 | (376) |
| Pumps and fans | 238.06 | x | 3.07 | = | 730.84 | (378) |
| Electricity for lighting | 425.01 | x | 3.07 | = | 1304.79 | (379) |
| Primary energy kWh/year |  |  |  |  | 8918.46 | (383) |
| Dwelling primary energy rate kWh/m2/year |  |  |  |  | 85.70 | (384) |

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco  Ali | Assessor number | 9526 |
| Client | | Last modified | 30/09/2020 |
| Address | 3B6P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 94.73 | (1a) | x | 2.50 | (2a) | = | 236.83 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 94.73 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 236.83 | (5) |

## 2. Ventilation rate

| | | | m³ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |

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

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.13 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.16 | 0.16 | 0.16 | 0.14 | 0.14 | 0.12 | 0.12 | 0.12 | 0.13 | 0.14 | 0.14 | 0.15 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 74.80 | (23c) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| a) If balanced mechanical ventilation with heat recovery (MVHR) (22b)m + (23b) x [1 - (23c) ÷ 100] | 0.29 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.25 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | (24a) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.29 | 0.29 | 0.28 | 0.27 | 0.26 | 0.25 | 0.25 | 0.24 | 0.25 | 0.26 | 0.27 | 0.28 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 14.86 | x | 1.24 | = | 18.36 | | | (27) |
| Door | | | 1.80 | x | 0.60 | = | 1.08 | | | (26) |
| External wall | | | 36.28 | x | 0.17 | = | 6.17 | | | (29a) |
| Party wall | | | 15.15 | x | 0.00 | = | 0.00 | | | (32) |
| External wall | | | 34.68 | x | 0.20 | = | 6.94 | | | (29a) |
| Roof | | | 94.73 | x | 0.13 | = | 12.31 | | | (30) |
| Total area of external elements ∑A, m² | | | 182.35 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 44.86 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 14.02 | (36) |
| Total fabric heat loss | (33) + (36) = | 58.88 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 22.55 | 22.30 | 22.05 | 20.81 | 20.56 | 19.31 | 19.31 | 19.06 | 19.81 | 20.56 | 21.06 | 21.56 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 81.44 | 81.19 | 80.94 | 79.69 | 79.44 | 78.20 | 78.20 | 77.95 | 78.70 | 79.44 | 79.94 | 80.44 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 79.63 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.86 | 0.86 | 0.85 | 0.84 | 0.84 | 0.83 | 0.83 | 0.82 | 0.83 | 0.84 | 0.84 | 0.85 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.84 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.69 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 97.97 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 107.77 | 103.85 | 99.93 | 96.01 | 92.09 | 88.17 | 88.17 | 92.09 | 96.01 | 99.93 | 103.85 | 107.77 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1175.65 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 159.82 | 139.78 | 144.24 | 125.75 | 120.66 | 104.12 | 96.48 | 110.72 | 112.04 | 130.57 | 142.53 | 154.77 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1541.46 | (45) |
| Distribution loss 0.15 x (45)m | 23.97 | 20.97 | 21.64 | 18.86 | 18.10 | 15.62 | 14.47 | 16.61 | 16.81 | 19.59 | 21.38 | 23.22 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |

Water storage loss:

b) Manufacturer's declared loss factor is not known

| | | |
|---|---|---|
| Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51) |
| Volume factor from Table 2a | 3.42 | (52) |
| Temperature factor from Table 2b | 0.60 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.13 | (54) |
| Enter (50) or (54) in (55) | 0.13 | (55) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |

Primary circuit loss for each month from Table 3

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 187.12 | 164.44 | 171.54 | 152.17 | 147.96 | 130.54 | 123.79 | 138.02 | 138.46 | 157.87 | 168.95 | 182.08 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 187.12 | 164.44 | 171.54 | 152.17 | 147.96 | 130.54 | 123.79 | 138.02 | 138.46 | 157.87 | 168.95 | 182.08 | |

∑(64)1...12 = 1862.94 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 74.98 | 66.20 | 69.80 | 62.95 | 61.96 | 55.76 | 53.92 | 58.66 | 58.39 | 65.26 | 68.53 | 73.31 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | 134.25 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 23.11 | 20.53 | 16.69 | 12.64 | 9.45 | 7.98 | 8.62 | 11.20 | 15.04 | 19.09 | 22.28 | 23.75 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 247.52 | 250.08 | 243.61 | 229.83 | 212.44 | 196.09 | 185.17 | 182.60 | 189.08 | 202.85 | 220.25 | 236.59 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | 36.43 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | -107.40 | (71) |
| Water heating gains (Table 5) | 100.78 | 98.52 | 93.82 | 87.43 | 83.28 | 77.44 | 72.48 | 78.84 | 81.10 | 87.71 | 95.18 | 98.53 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 434.69 | 432.41 | 417.40 | 393.18 | 368.45 | 344.79 | 329.54 | 335.92 | 348.49 | 372.93 | 400.98 | 422.15 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.77 | x | 10.44 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 44.76 | (76) |
| South | 0.77 | x | 4.42 | x | 46.75 | x 0.9 x | 0.45 | x | 0.70 | = | 45.11 | (78) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 89.87 | 161.44 | 238.31 | 316.67 | 368.57 | 370.50 | 355.40 | 316.98 | 266.02 | 183.58 | 109.28 | 75.79 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 524.56 | 593.85 | 655.71 | 709.85 | 737.02 | 715.29 | 684.95 | 652.90 | 614.50 | 556.51 | 510.27 | 497.94 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 1.00 | 0.99 | 0.96 | 0.87 | 0.68 | 0.50 | 0.54 | 0.81 | 0.97 | 1.00 | 1.00 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 20.12 | 20.25 | 20.45 | 20.70 | 20.90 | 20.98 | 21.00 | 21.00 | 20.95 | 20.70 | 20.37 | 20.10 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C) | 20.20 | 20.20 | 20.21 | 20.22 | 20.22 | 20.23 | 20.23 | 20.23 | 20.23 | 20.22 | 20.22 | 20.21 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 1.00 | 1.00 | 0.99 | 0.95 | 0.83 | 0.61 | 0.41 | 0.46 | 0.74 | 0.96 | 1.00 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 19.02 | 19.20 | 19.50 | 19.86 | 20.12 | 20.22 | 20.23 | 20.23 | 20.19 | 19.87 | 19.38 | 19.00 | (90) |

Living area fraction Living area ÷ (4) = 0.33 (91)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | 19.38 | 19.55 | 19.81 | 20.14 | 20.37 | 20.47 | 20.48 | 20.48 | 20.44 | 20.14 | 19.71 | 19.36 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 19.38 | 19.55 | 19.81 | 20.14 | 20.37 | 20.47 | 20.48 | 20.48 | 20.44 | 20.14 | 19.71 | 19.36 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 1.00 | 0.99 | 0.98 | 0.94 | 0.84 | 0.63 | 0.44 | 0.49 | 0.76 | 0.96 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 523.24 | 590.34 | 644.84 | 670.52 | 616.23 | 450.06 | 302.87 | 316.93 | 468.83 | 534.66 | 507.20 | 497.03 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1228.32 | 1189.33 | 1077.28 | 895.73 | 689.03 | 459.16 | 303.66 | 318.33 | 498.88 | 758.06 | 1007.88 | 1219.55 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 524.58 | 402.52 | 321.74 | 162.15 | 54.16 | 0.00 | 0.00 | 0.00 | 0.00 | 166.21 | 360.49 | 537.56 | |

∑(98)1...5, 10...12 = 2529.40 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 26.70 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from boilers | | 1.00 | (303a) |
| Fraction of total space heat from community boilers | (302) x (303a) = | 1.00 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community space heating | | 1.00 | (305) |
| Factor for charging method (Table 4c(3)) for community water heating | | 1.00 | (305a) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |

**Space heating**

| | | | |
|---|---|---|---|
| Annual space heating requirement | 2529.40 | | (98) |
| Space heat from boilers | (98) x (304a) x (305) x (306) = | 2655.87 | (307a) |

**Water heating**

| | | | |
|---|---|---|---|
| Annual water heating requirement | 1862.94 | | (64) |
| Water heat from boilers | (64) x (303a) x (305a) x (306) = | 1956.09 | (310a) |

| | | | |
|---|---|---|---|
| Electricity used for heat distribution | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 46.12 | (313) |

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

| | | | |
|---|---|---|---|
| mechanical ventilation fans - balanced, extract or positive input from outside | 216.69 | | (330a) |
| Total electricity for the above, kWh/year | | 216.69 | (331) |
| Electricity for lighting (Appendix L) | | 408.17 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 5236.83 | (338) |

### 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 2655.87 | x | 4.24 | x 0.01 = | 112.61 | (340a) |
| Water heating from boilers | 1956.09 | x | 4.24 | x 0.01 = | 82.94 | (342a) |
| Pumps and fans | 216.69 | x | 13.19 | x 0.01 = | 28.58 | (349) |
| Electricity for lighting | 408.17 | x | 13.19 | x 0.01 = | 53.84 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 397.97 | (355) |

### 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.20 | (357) |
| SAP value | 83.31 | |
| SAP rating (section 13) | 83 | (358) |
| SAP band | B | |

### 12b. $CO_2$ emissions - community heating scheme

| | Energy kWh/year | | Emission factor | | Emissions (kg/year) | |
|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | |
| Efficiency of boilers | 89.50 | | | | | (367a) |
| CO2 emissions from boilers [(307a)+(310a)] x 100 ÷ (367a) = | 5153.03 | x | 0.216 | = | 1113.05 | (367) |
| Electrical energy for community heat distribution | 46.12 | x | 0.519 | = | 23.94 | (372) |
| Total CO2 associated with community systems | | | | | 1136.99 | (373) |
| Total CO2 associated with space and water heating | | | | | 1136.99 | (376) |
| Pumps and fans | 216.69 | x | 0.519 | = | 112.46 | (378) |
| Electricity for lighting | 408.17 | x | 0.519 | = | 211.84 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 1461.30 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 15.43 | (384) |
| EI value | | | | | 85.99 | |
| EI rating (section 14) | | | | | 86 | (385) |
| EI band | | | | | B | |

### 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of boilers | 89.50 | | | | | (367a) |
| Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) = | 5153.03 | x | 1.22 | = | 6286.70 | (367) |
| Electrical energy for community heat distribution | 46.12 | x | 3.07 | = | 141.59 | (372) |
| Total primary energy associated with community systems | | | | | 6428.28 | (373) |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| Total primary energy associated with space and water heating |  |  |  |  | 6428.28 | (376) |
| Pumps and fans | 216.69 | x | 3.07 | = | 665.25 | (378) |
| Electricity for lighting | 408.17 | x | 3.07 | = | 1253.08 | (379) |
| Primary energy kWh/year |  |  |  |  | 8346.62 | (383) |
| Dwelling primary energy rate kWh/m2/year |  |  |  |  | 88.11 | (384) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Nimco Ali | Assessor number | 9526 |
| Client | | Last modified | 23/10/2020 |
| Address | 4B8P, Kingston upon Thames, KT1 | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 72.24 | (1a) | x | 2.50 | (2a) | = | 180.60 | (3a) |
| +1 | | 57.20 | (1b) | x | 2.50 | (2b) | = | 143.00 | (3b) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 129.44 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 323.60 | (5) |

## 2. Ventilation rate

| | | | | m³ per hour | |
|---|---|---|---|---|---|
| Number of chimneys | | 0 | x 40 = | 0 | (6a) |
| Number of open flues | | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | 0 | x 10 = | 0 | (7a) |
| Number of passive vents | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | 0 | x 40 = | 0 | (7c) |
| | | | | Air changes per hour | |
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 0 | ÷ (5) = | 0.00 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 3.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.15 | (18) |
| Number of sides on which the dwelling is sheltered | | 2 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.85 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.13 | (21) |

Infiltration rate modified for monthly wind speed:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table U2 | 5.10 | 5.00 | 4.90 | 4.40 | 4.30 | 3.80 | 3.80 | 3.70 | 4.00 | 4.30 | 4.50 | 4.70 | (22) |
| Wind factor (22)m ÷ 4 | 1.28 | 1.25 | 1.23 | 1.10 | 1.08 | 0.95 | 0.95 | 0.93 | 1.00 | 1.08 | 1.13 | 1.18 | (22a) |
| Adjusted infiltration rate (allowing for shelter and wind factor) (21) x (22a)m | 0.16 | 0.16 | 0.16 | 0.14 | 0.14 | 0.12 | 0.12 | 0.12 | 0.13 | 0.14 | 0.14 | 0.15 | (22b) |

Calculate effective air change rate for the applicable case:

| | | |
|---|---|---|
| If mechanical ventilation: air change rate through system | 0.50 | (23a) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor from Table 4h | 73.10 | (23c) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.30 | 0.29 | 0.29 | 0.27 | 0.27 | 0.26 | 0.26 | 0.25 | 0.26 | 0.27 | 0.28 | 0.28 | (24a) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.30 | 0.29 | 0.29 | 0.27 | 0.27 | 0.26 | 0.26 | 0.25 | 0.26 | 0.27 | 0.28 | 0.28 | (25) |

## 3. Heat losses and heat loss parameter

| Element | Gross area, m² | Openings m² | Net area A, m² | | U-value W/m²K | | A x U W/K | κ-value, kJ/m².K | A x κ, kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Window | | | 23.72 | x | 1.24 | = | 29.31 | | | (27) |
| Door | | | 1.80 | x | 1.30 | = | 2.34 | | | (26) |
| Ground floor | | | 72.24 | x | 0.10 | = | 7.22 | | | (28a) |
| External wall | | | 64.31 | x | 0.17 | = | 10.93 | | | (29a) |
| Party wall | | | 79.95 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 15.04 | x | 0.13 | = | 1.96 | | | (30) |
| Roof | | | 2.58 | x | 0.16 | = | 0.41 | | | (30) |
| Total area of external elements ∑A, m² | | | 179.69 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 52.18 | (33) |
| Heat capacity Cm = ∑(A x κ) | (28)...(30) + (32) + (32a)...(32e) = | N/A | (34) |
| Thermal mass parameter (TMP) in kJ/m²K | | 250.00 | (35) |
| Thermal bridges: ∑(L x Ψ) calculated using Appendix K | | 14.96 | (36) |
| Total fabric heat loss | (33) + (36) = | 67.14 | (37) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.72 | 31.38 | 31.04 | 29.34 | 29.00 | 27.30 | 27.30 | 26.96 | 27.98 | 29.00 | 29.68 | 30.36 | (38) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 98.86 | 98.52 | 98.18 | 96.48 | 96.14 | 94.43 | 94.43 | 94.09 | 95.11 | 96.14 | 96.82 | 97.50 | |

Average = ∑(39)1...12/12 = 96.39 (39)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.76 | 0.76 | 0.76 | 0.75 | 0.74 | 0.73 | 0.73 | 0.73 | 0.73 | 0.74 | 0.75 | 0.75 | |

Average = ∑(40)1...12/12 = 0.74 (40)

Number of days in month (Table 1a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.89 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 102.92 | (43) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 113.21 | 109.10 | 104.98 | 100.86 | 96.75 | 92.63 | 92.63 | 96.75 | 100.86 | 104.98 | 109.10 | 113.21 | |

∑(44)1...12 = 1235.05 (44)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 167.89 | 146.84 | 151.53 | 132.10 | 126.76 | 109.38 | 101.36 | 116.31 | 117.70 | 137.17 | 149.73 | 162.59 | |

∑(45)1...12 = 1619.35 (45)

Distribution loss 0.15 x (45)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 25.18 | 22.03 | 22.73 | 19.82 | 19.01 | 16.41 | 15.20 | 17.45 | 17.65 | 20.57 | 22.46 | 24.39 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 3.00 | (47) |

Water storage loss:

b) Manufacturer's declared loss factor is not known

| | | |
|---|---|---|
| Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.02 | (51) |
| Volume factor from Table 2a | 3.42 | (52) |
| Temperature factor from Table 2b | 0.60 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.13 | (54) |

Enter (50) or (54) in (55) 0.13 (55)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | | | | | | | | | | | | |
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | | | | | | | | | | | | |
| 4.04 | 3.65 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | 4.04 | 3.91 | 4.04 | 3.91 | 4.04 | (57) |
| Primary circuit loss for each month from Table 3 | | | | | | | | | | | | |
| 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |
| Combi loss for each month from Table 3a, 3b or 3c | | | | | | | | | | | | |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (61) |
| Total heat required for water heating calculated for each month 0.85 x (45)m + (46)m + (57)m + (59)m + (61)m | | | | | | | | | | | | |
| 195.20 | 171.50 | 178.83 | 158.53 | 154.06 | 135.80 | 128.66 | 143.61 | 144.12 | 164.47 | 176.15 | 189.90 | (62) |
| Solar DHW input calculated using Appendix G or Appendix H | | | | | | | | | | | | |
| 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (63) |
| Output from water heater for each month (kWh/month) (62)m + (63)m | | | | | | | | | | | | |
| 195.20 | 171.50 | 178.83 | 158.53 | 154.06 | 135.80 | 128.66 | 143.61 | 144.12 | 164.47 | 176.15 | 189.90 | |

∑(64)1...12 = 1940.83 (64)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m] | | | | | | | | | | | | |
| 77.67 | 68.55 | 72.22 | 65.06 | 63.99 | 57.51 | 55.54 | 60.52 | 60.27 | 67.45 | 70.92 | 75.91 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | 144.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 26.97 | 23.96 | 19.48 | 14.75 | 11.03 | 9.31 | 10.06 | 13.07 | 17.55 | 22.28 | 26.00 | 27.72 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 297.04 | 300.13 | 292.36 | 275.82 | 254.95 | 235.33 | 222.22 | 219.14 | 226.91 | 243.45 | 264.32 | 283.94 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | 37.47 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | -115.74 | (71) |
| Water heating gains (Table 5) | 104.39 | 102.01 | 97.08 | 90.36 | 86.01 | 79.87 | 74.66 | 81.34 | 83.71 | 90.66 | 98.50 | 102.02 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 494.81 | 492.50 | 475.32 | 447.34 | 418.38 | 390.91 | 373.34 | 379.96 | 394.57 | 422.79 | 455.23 | 480.09 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.77 | x | 9.04 | x | 46.75 | x 0.9 x | 0.50 | x | 0.70 | = | 102.51 | (78) |
| East | 0.77 | x | 10.68 | x | 19.64 | x 0.9 x | 0.45 | x | 0.70 | = | 45.79 | (76) |
| SouthEast | 0.77 | x | 4.00 | x | 36.79 | x 0.9 x | 0.50 | x | 0.70 | = | 35.70 | (77) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | | | | | | | | | | | | |
| 184.00 | 318.27 | 444.57 | 559.93 | 631.00 | 626.93 | 604.31 | 552.00 | 485.05 | 354.57 | 221.36 | 156.78 | (83) |
| Total gains - internal and solar (73)m + (83)m | | | | | | | | | | | | |
| 678.81 | 810.77 | 919.89 | 1007.27 | 1049.38 | 1017.84 | 977.65 | 931.96 | 879.62 | 777.36 | 676.59 | 636.87 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 1.00 | 0.98 | 0.93 | 0.80 | 0.59 | 0.42 | 0.46 | 0.72 | 0.96 | 1.00 | 1.00 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 20.24 | 20.39 | 20.59 | 20.82 | 20.96 | 21.00 | 21.00 | 21.00 | 20.98 | 20.80 | 20.47 | 20.22 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C) | 20.28 | 20.29 | 20.29 | 20.30 | 20.30 | 20.31 | 20.31 | 20.32 | 20.31 | 20.30 | 20.30 | 20.29 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 1.00 | 0.99 | 0.98 | 0.91 | 0.75 | 0.53 | 0.36 | 0.40 | 0.66 | 0.94 | 1.00 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 19.25 | 19.48 | 19.77 | 20.09 | 20.26 | 20.31 | 20.31 | 20.32 | 20.30 | 20.07 | 19.61 | 19.23 | (90) |

Living area fraction Living area ÷ (4) = 0.30 (91)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temperature for the whole dwelling fLA x T1 +(1 - fLA) x T2 | 19.55 | 19.75 | 20.02 | 20.31 | 20.47 | 20.52 | 20.52 | 20.52 | 20.50 | 20.29 | 19.87 | 19.52 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 19.55 | 19.75 | 20.02 | 20.31 | 20.47 | 20.52 | 20.52 | 20.52 | 20.50 | 20.29 | 19.87 | 19.52 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 1.00 | 0.99 | 0.98 | 0.91 | 0.76 | 0.55 | 0.38 | 0.42 | 0.68 | 0.94 | 0.99 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 677.47 | 805.20 | 897.89 | 920.24 | 802.43 | 555.80 | 370.14 | 387.58 | 595.71 | 732.56 | 672.54 | 636.04 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1507.74 | 1463.21 | 1327.29 | 1101.17 | 843.21 | 558.90 | 370.32 | 387.94 | 609.16 | 931.85 | 1236.13 | 1494.12 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 617.72 | 442.19 | 319.47 | 130.26 | 30.34 | 0.00 | 0.00 | 0.00 | 0.00 | 148.28 | 405.78 | 638.41 | |

∑(98)1...5, 10...12 = 2732.45 (98)

Space heating requirement kWh/m²/year (98) ÷ (4) 21.11 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from boilers | | 1.00 | (303a) |
| Fraction of total space heat from community boilers | (302) x (303a) = | 1.00 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community space heating | | 1.00 | (305) |
| Factor for charging method (Table 4c(3)) for community water heating | | 1.00 | (305a) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |

**Space heating**

Annual space heating requirement 2732.45 (98)

Space heat from boilers (98) x (304a) x (305) x (306) = 2869.07 (307a)

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | | 1940.83 | | (64) |
| Water heat from boilers | (64) x (303a) x (305a) x (306) = | | 2037.87 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | | 49.07 | (313) |

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

| | | | | |
|---|---|---|---|---|
| mechanical ventilation fans - balanced, extract or positive input from outside | | 350.38 | | (330a) |
| Total electricity for the above, kWh/year | | | 350.38 | (331) |
| Electricity for lighting (Appendix L) | | | 476.33 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | | 5733.65 | (338) |

## 10b. Fuel costs - community heating scheme

| | **Fuel kWh/year** | | **Fuel price** | | **Fuel cost £/year** | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 2869.07 | x | 4.24 | x 0.01 = | 121.65 | (340a) |
| Water heating from boilers | 2037.87 | x | 4.24 | x 0.01 = | 86.41 | (342a) |
| Pumps and fans | 350.38 | x | 13.19 | x 0.01 = | 46.21 | (349) |
| Electricity for lighting | 476.33 | x | 13.19 | x 0.01 = | 62.83 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 437.10 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.05 | (357) |
| SAP value | 85.32 | |
| SAP rating (section 13) | 85 | (358) |
| SAP band | B | |

## 12b. $CO_2$ emissions - community heating scheme

| | | **Energy kWh/year** | | **Emission factor** | | **Emissions (kg/year)** | |
|---|---|---|---|---|---|---|---|
| Emissions from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| CO2 emissions from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 5482.61 | x | 0.216 | = | 1184.24 | (367) |
| Electrical energy for community heat distribution | | 49.07 | x | 0.519 | = | 25.47 | (372) |
| Total CO2 associated with community systems | | | | | | 1209.71 | (373) |
| Total CO2 associated with space and water heating | | | | | | 1209.71 | (376) |
| Pumps and fans | | 350.38 | x | 0.519 | = | 181.85 | (378) |
| Electricity for lighting | | 476.33 | x | 0.519 | = | 247.22 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 1638.77 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 12.66 | (384) |
| EI value | | | | | | 87.41 | |
| EI rating (section 14) | | | | | | 87 | (385) |
| EI band | | | | | | B | |

## 13b. Primary energy - community heating scheme

| | | **Energy kWh/year** | | **Primary factor** | | **Primary energy (kWh/year)** | |
|---|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | | |
| Efficiency of boilers | | 89.50 | | | | | (367a) |
| Primary energy from boilers | [(307a)+(310a)] x 100 ÷ (367a) = | 5482.61 | x | 1.22 | = | 6688.79 | (367) |

|  |  |  |  |  |  |  |
|---|---|---|---|---|---|---|
| Electrical energy for community heat distribution | 49.07 | x | 3.07 | = | 150.64 | (372) |
| Total primary energy associated with community systems |  |  |  |  | 6839.43 | (373) |
| Total primary energy associated with space and water heating |  |  |  |  | 6839.43 | (376) |
| Pumps and fans | 350.38 | x | 3.07 | = | 1075.66 | (378) |
| Electricity for lighting | 476.33 | x | 3.07 | = | 1462.34 | (379) |
| Primary energy kWh/year |  |  |  |  | 9377.43 | (383) |
| Dwelling primary energy rate kWh/m2/year |  |  |  |  | 72.45 | (384) |

# Appendix D BRUKL – *Be Lean*

# BRUKL Output Document

HM Government

## Compliance with England Building Regulations Part L 2013

**Project name**

# Cambridge Road Estate Commercial Units

As designed

**Date:** Wed Sep 30 17:46:23 2020

## Administrative information

### Building Details

**Address:** ,

### Certification tool

**Calculation engine:** SBEM

**Calculation engine version:** v5.6.b.0

**Interface to calculation engine:** DesignBuilder SBEM

**Interface to calculation engine version:** v6.1.7

**BRUKL compliance check version:** v5.6.b.0

### Certifier details

**Name:**

**Telephone number:**

**Address:** , ,

## Criterion 1: The calculated $CO_2$ emission rate for the building must not exceed the target

| | |
|---|---|
| $CO_2$ emission rate from the notional building, $kgCO_2/m^2$.annum | 11.8 |
| Target $CO_2$ emission rate (TER), $kgCO_2/m^2$.annum | 11.8 |
| Building $CO_2$ emission rate (BER), $kgCO_2/m^2$.annum | 8.8 |
| Are emissions from the building less than or equal to the target? | BER =< TER |
| Are as built details the same as used in the BER calculations? | Separate submission |

## Criterion 2: The performance of the building fabric and fixed building services should achieve reasonable overall standards of energy efficiency

**Values which do not achieve the standards in the Non-Domestic Building Services Compliance Guide and Part L are displayed in red.**

**Building fabric**

| **Element** | **$U_{a\text{-Limit}}$** | **$U_{a\text{-Calc}}$** | **$U_{i\text{-Calc}}$** | **Surface where the maximum value occurs*** |
|---|---|---|---|---|
| Wall** | 0.35 | 0.18 | 0.3 | "01 Ground Floor - Community Space_W_18" |
| Floor | 0.25 | 0.15 | 0.15 | "01 Ground Floor - Community Space_F_2" |
| Roof | 0.25 | 0.13 | 0.13 | "01 Ground Floor - Community Space_R_5" |
| Windows***, roof windows, and rooflights | 2.2 | 1.3 | 1.3 | "01 Ground Floor - Community Space_G_9" |
| Personnel doors | 2.2 | - | - | "No external personnel doors" |
| Vehicle access & similar large doors | 1.5 | - | - | "No external vehicle access doors" |
| High usage entrance doors | 3.5 | - | - | "No external high usage entrance doors" |

$U_{a\text{-Limit}}$ = Limiting area-weighted average U-values [W/(m²K)]
$U_{a\text{-Calc}}$ = Calculated area-weighted average U-values [W/(m²K)]
$U_{i\text{-Calc}}$ = Calculated maximum individual element U-values [W/(m²K)]

* There might be more than one surface where the maximum U-value occurs.
** Automatic U-value check by the tool does not apply to curtain walls whose limiting standard is similar to that for windows.
*** Display windows and similar glazing are excluded from the U-value check.
N.B.: Neither roof ventilators (inc. smoke vents) nor swimming pool basins are modelled or checked against the limiting standards by the tool.

| **Air Permeability** | **Worst acceptable standard** | **This building** |
|---|---|---|
| $m^3/(h.m^2)$ at 50 Pa | 10 | 5 |

## Building services

**The standard values listed below are minimum values for efficiencies and maximum values for SFPs. Refer to the Non-Domestic Building Services Compliance Guide for details.**

| | |
|---|---|
| **Whole building lighting automatic monitoring & targeting with alarms for out-of-range values** | YES |
| **Whole building electric power factor achieved by power factor correction** | <0.9 |

1- Communal Heating

| | **Heating efficiency** | **Cooling efficiency** | **Radiant efficiency** | **SFP [W/(l/s)]** | **HR efficiency** |
|---|---|---|---|---|---|
| **This system** | 0.91 | 4.2 | - | - | - |
| **Standard value** | 0.91* | N/A | N/A | N/A | N/A |
| **Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system** | | | | | NO |

* Standard shown is for gas single boiler systems <=2 MW output. For single boiler systems >2 MW or multi-boiler systems, (overall) limiting efficiency is 0.86. For any individual boiler in a multi-boiler system, limiting efficiency is 0.82.

1- Project DHW

| | **Water heating efficiency** | **Storage loss factor [kWh/litre per day]** |
|---|---|---|
| **This building** | Hot water provided by HVAC system | - |
| **Standard value** | N/A | N/A |

### Local mechanical ventilation, exhaust, and terminal units

| **ID** | **System type in Non-domestic Building Services Compliance Guide** |
|---|---|
| A | Local supply or extract ventilation units serving a single area |
| B | Zonal supply system where the fan is remote from the zone |
| C | Zonal extract system where the fan is remote from the zone |
| D | Zonal supply and extract ventilation units serving a single room or zone with heating and heat recovery |
| E | Local supply and extract ventilation system serving a single area with heating and heat recovery |
| F | Other local ventilation units |
| G | Fan-assisted terminal VAV unit |
| H | Fan coil units |
| I | Zonal extract system where the fan is remote from the zone with grease filter |

| **Zone name** | **SFP [W/(l/s)]** | | | | | | | | | **HR efficiency** | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **ID of system type** | **A** | **B** | **C** | **D** | **E** | **F** | **G** | **H** | **I** | | |
| **Standard value** | 0.3 | 1.1 | 0.5 | 1.9 | 1.6 | 0.5 | 1.1 | 0.5 | 1 | **Zone** | **Standard** |
| 01 Ground Floor - Community Space | - | - | - | 1.4 | - | - | - | - | - | 0.85 | 0.5 |
| 01 Ground Floor - Retail | - | - | - | 1.4 | - | - | - | - | - | 0.85 | 0.5 |
| 01 Ground Floor - Workspace | - | - | - | 1.4 | - | - | - | - | - | 0.85 | 0.5 |
| 02 First Floor 1 - Community Space | - | - | - | 1.4 | - | - | - | - | - | 0.85 | 0.5 |

### General lighting and display lighting

| | **Luminous efficacy [lm/W]** | | | |
|---|---|---|---|---|
| **Zone name** | **Luminaire** | **Lamp** | **Display lamp** | **General lighting [W]** |
| **Standard value** | 60 | 60 | 22 | |
| 01 Ground Floor - Community Space | - | 110 | - | 6776 |
| 01 Ground Floor - Retail | - | 110 | 75 | 1868 |
| 01 Ground Floor - Workspace | 110 | - | - | 1254 |
| 02 First Floor 1 - Community Space | - | 110 | - | 1768 |

## Criterion 3: The spaces in the building should have appropriate passive control measures to limit solar gains

| Zone | Solar gain limit exceeded? (%) | Internal blinds used? |
|---|---|---|
| 01 Ground Floor - Community Space | NO (-70.3%) | NO |
| 01 Ground Floor - Retail | NO (-55%) | NO |
| 01 Ground Floor - Workspace | NO (-25.6%) | NO |
| 02 First Floor 1 - Community Space | NO (-44.2%) | NO |

## Criterion 4: The performance of the building, as built, should be consistent with the calculated BER

Separate submission

## Criterion 5: The necessary provisions for enabling energy-efficient operation of the building should be in place

Separate submission

## EPBD (Recast): Consideration of alternative energy systems

| **Were alternative energy systems considered and analysed as part of the design process?** | NO |
|---|---|
| Is evidence of such assessment available as a separate submission? | NO |
| Are any such measures included in the proposed design? | NO |

# Technical Data Sheet (Actual vs. Notional Building)

## Building Global Parameters

| | Actual | Notional |
|---|---|---|
| Area [m$^2$] | 2474.4 | 2474.4 |
| External area [m$^2$] | 4832.7 | 4832.7 |
| Weather | LON | LON |
| Infiltration [m$^3$/hm$^2$@ 50Pa] | 5 | 6 |
| Average conductance [W/K] | 1571.51 | 1575.04 |
| Average U-value [W/m$^2$K] | 0.33 | 0.33 |
| Alpha value* [%] | 10.65 | 28.18 |

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

## Building Use

| % Area | Building Type |
|---|---|
| **9** | **A1/A2 Retail/Financial and Professional services** |
| | A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways |
| **9** | **B1 Offices and Workshop businesses** |
| | B2 to B7 General Industrial and Special Industrial Groups |
| | B8 Storage or Distribution |
| | C1 Hotels |
| | C2 Residential Institutions: Hospitals and Care Homes |
| | C2 Residential Institutions: Residential schools |
| | C2 Residential Institutions: Universities and colleges |
| | C2A Secure Residential Institutions |
| | Residential spaces |
| **83** | **D1 Non-residential Institutions: Community/Day Centre** |
| | D1 Non-residential Institutions: Libraries, Museums, and Galleries |
| | D1 Non-residential Institutions: Education |
| | D1 Non-residential Institutions: Primary Health Care Building |
| | D1 Non-residential Institutions: Crown and County Courts |
| | D2 General Assembly and Leisure, Night Clubs, and Theatres |
| | Others: Passenger terminals |
| | Others: Emergency services |
| | Others: Miscellaneous 24hr activities |
| | Others: Car Parks 24 hrs |
| | Others: Stand alone utility block |

## Energy Consumption by End Use [kWh/m$^2$]

| | Actual | Notional |
|---|---|---|
| Heating | 11.1 | 11.08 |
| Cooling | 2.29 | 3.76 |
| Auxiliary | 2.23 | 1.43 |
| Lighting | 7.72 | 13.14 |
| Hot water | 0.46 | 0.46 |
| Equipment* | 10.12 | 10.12 |
| **TOTAL**** | **23.8** | **29.88** |

* Energy used by equipment does not count towards the total for consumption or calculating emissions.
** Total is net of any electrical energy displaced by CHP generators, if applicable.

## Energy Production by Technology [kWh/m$^2$]

| | Actual | Notional |
|---|---|---|
| Photovoltaic systems | 0 | 0 |
| Wind turbines | 0 | 0 |
| CHP generators | 0 | 0 |
| Solar thermal systems | 0 | 0 |

## Energy & $CO_2$ Emissions Summary

| | Actual | Notional |
|---|---|---|
| Heating + cooling demand [MJ/m$^2$] | 71.95 | 81.42 |
| Primary energy* [kWh/m$^2$] | 51.67 | 68.97 |
| Total emissions [kg/m$^2$] | 8.8 | 11.8 |

* Primary energy is net of any electrical energy displaced by CHP generators, if applicable.

## HVAC Systems Performance

| System Type | | Heat dem MJ/m2 | Cool dem MJ/m2 | Heat con kWh/m2 | Cool con kWh/m2 | Aux con kWh/m2 | Heat SSEEF | Cool SSEER | Heat gen SEFF | Cool gen SEER |
|---|---|---|---|---|---|---|---|---|---|---|
| **[ST] Split or multi-split system, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity** | | | | | | | | | | |
| | **Actual** | 33.9 | 38.1 | 11.1 | 2.3 | 2.2 | 0.85 | 4.62 | 0.91 | 6.5 |
| | **Notional** | 32.7 | 48.7 | 11.1 | 3.8 | 1.4 | 0.82 | 3.6 | ---- | ---- |

## Key to terms

| | |
|---|---|
| Heat dem [MJ/m2] | = Heating energy demand |
| Cool dem [MJ/m2] | = Cooling energy demand |
| Heat con [kWh/m2] | = Heating energy consumption |
| Cool con [kWh/m2] | = Cooling energy consumption |
| Aux con [kWh/m2] | = Auxiliary energy consumption |
| Heat SSEFF | = Heating system seasonal efficiency (for notional building, value depends on activity glazing class) |
| Cool SSEER | = Cooling system seasonal energy efficiency ratio |
| Heat gen SSEFF | = Heating generator seasonal efficiency |
| Cool gen SSEER | = Cooling generator seasonal energy efficiency ratio |
| ST | = System type |
| HS | = Heat source |
| HFT | = Heating fuel type |
| CFT | = Cooling fuel type |

# Key Features

**The Building Control Body is advised to give particular attention to items whose specifications are better than typically expected.**

**Building fabric**

| **Element** | **$U_{i\text{-}Typ}$** | **$U_{i\text{-}Min}$** | **Surface where the minimum value occurs*** |
|---|---|---|---|
| Wall | 0.23 | 0.17 | "01 Ground Floor - Community Space_W_8" |
| Floor | 0.2 | 0.15 | "01 Ground Floor - Community Space_F_2" |
| Roof | 0.15 | 0.13 | "01 Ground Floor - Community Space_R_5" |
| Windows, roof windows, and rooflights | 1.5 | 1.3 | "01 Ground Floor - Community Space_G_9" |
| Personnel doors | 1.5 | - | "No external personnel doors" |
| Vehicle access & similar large doors | 1.5 | - | "No external vehicle access doors" |
| High usage entrance doors | 1.5 | - | "No external high usage entrance doors" |

$U_{i\text{-}Typ}$ = Typical individual element U-values [W/(m²K)]

$U_{i\text{-}Min}$ = Minimum individual element U-values [W/(m²K)]

* There might be more than one surface where the minimum U-value occurs.

| **Air Permeability** | **Typical value** | **This building** |
|---|---|---|
| $m^3/(h.m^2)$ at 50 Pa | 5 | 5 |

# Appendix E Dynamic Overheating Assessment

**Dynamic Overheating Assessment**

Cambridge Road (RBK) LLP

# Cambridge Road Estate

Final

**Chiara Fratter**
BArch, MSc (Hons), CEng MCIBSE

October 2020

# DOCUMENT CONTROL RECORD

## REPORT STATUS: FINAL

| Version | Date | Reason for issue | Author | Checked by | Approved for Issue by Project Manager |
|---|---|---|---|---|---|
| v.1 | 02.10.2020 | Draft | CFR | KP | ND |
| v.2 | 26.10.2020 | Final | CFR | KP | ND |
| | | | | | |

## ABOUT HODKINSON CONSULTANCY

Our team of technical specialists offer advanced levels of expertise and experience to our clients. We have a wide experience of the construction and development industry and tailor teams to suit each individual project.

We are able to advise at all stages of projects from planning applications to handover.

Our emphasis is to provide innovative and cost-effective solutions that respond to increasing demands for quality and construction efficiency.

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This report has been prepared by Hodkinson Consultancy using all reasonable skill, care and diligence and using evidence supplied by the design team, client and where relevant through desktop research.

Hodkinson Consultancy can accept no responsibility for misinformation or inaccurate information supplied by any third party as part of this assessment.

# Executive Summary

This report details the methodology and findings of the dynamic overheating assessment of representative dwellings in support of the Hybrid planning application for the proposed Cambridge Road Estate by Cambridge Road (RBK) LLP in the Royal Borough of Kingston upon Thames. This document outlines the overheating mitigation strategy for Blocks B, C, and E of Phase 1 (the detailed component) of the Cambridge Road Estate masterplan scheme.

The analysis has been undertaken in line with the current London Plan (2016) Policy 5.9 *Overheating and cooling*, the Intend to Publish London Plan (2019) Policy SI4: *Managing heat risk* and the Royal Borough of Kingston upon Thames overheating policies.

Dwellings have been selected for the overheating assessment based on design characteristics that establish them as representative of the overall proposed scheme. This selection of dwellings includes consideration of varying floors and of different orientations. Air quality and noise constraints have also been considered as part of the overheating strategy in accordance with Intend to be Publish London Plan Policy D3 *Optimising site capacity through the design-led approach (3.3.9)*.

For the purposes of this report, it is assumed that dwellings will utilise openable windows as the primary means of ventilation, with a background mechanical ventilation system. Passive measures, for example, high energy efficiency, solar control glazing, and external shading in form of balconies have been explored and adopted as far as practicable to avoid the need for comfort cooling.

The performance of the dwellings has been assessed against the Charted Institute of Building Services Engineers (CIBSE) guidance CIBSE TM59: *Design Methodology for the Assessment of Overheating Risk in Homes* (2017). This dynamic overheating assessment of representative dwellings demonstrates that an acceptable overheating risk is achieved.

All dwellings assessed demonstrate an acceptable risk of overheating under mandatory Design Summer Year (DSY 1) weather conditions. The results are based on some key design features that follow the London Plan ‘cooling hierarchy’, as shown in Table i.

Similar overheating results are expected for the other blocks which are part of the Outline. However additional dynamic overheating modelling will be carried out for each future Reserved Matter Applications to ensure the risk of overheating is reduced.

**Table i: Design features to address the cooling hierarchy (London Plan Policy SI4).**

| Cooling Hierarchy | Design Feature | Discussion |
|---|---|---|
| **1. Reduce the amount of heat entering the building** | Highly efficient building fabric and air tightness standards. | *As per Energy Statement* |
| | Solar control glazing with g-value of 0.45 for the apartments and 0.50 for the houses (Blocks C & E). | *A low G-value reduces the solar gains, therefore assists in mitigation of overheating. However, it has implications on operational* |

**Table i: Design features to address the cooling hierarchy (London Plan Policy SI4).**

| Cooling Hierarchy | Design Feature | Discussion |
|---|---|---|
| | | *carbon emissions, fabric energy efficiency and internal daylight levels and has therefore been optimised to balance all aspects as far as possible.* |
| | **External shading**: Balcony overhangs across all blocks are included in the model as per design proposals.<br>**Internal shading:** Solar reflective blinds (70% solar reflectance) in all bedrooms on the noisy facades in blocks C1&C2. | *External shading is considered one of the most effective methods for solar control and overheating mitigation.*<br>*When external shading cannot be used the use of internal blinds can help to reduce internal solar gains.* |
| **2. Minimise internal heat generation** | Energy efficient design of building services including communal heating pipework. | |
| **3. Manage the heat** | A concrete 225mm slab has been assumed between dwellings. The thermal mass of this will help reduce the risk of overheating by absorbing heat during the daytime. | |
| **4. Natural ventilation** | **Non-sensitive noise facades:**<br>Windows and glazed doors are assumed fully openable during occupied hours.<br>**Window schedules:**<br>Kitchen/Living Rooms: 9:00-22:00<br>Bedrooms: 24/7 (Space is considered used as study/home office during the day)<br>**Sensitive noise facades:**<br>Windows and glazed doors are assumed openable when the spaces are not in use to limit resident's exposure to noise. Bedrooms will require windows to be open for some hours during the hottest nights of the summer to reduce the risk of overheating.<br>**Window schedules:**<br>Kitchen/Living Rooms: 22:00-09:00<br>Bedrooms: 07:00-01:00 | *Windows are simulated to be open when internal temperature exceeds 22°C and when external temperature is lower than the internal temperature:* $T_{indoor} > 22°C$, $T_{outdoor} < T_{indoor}$<br>*Night-time ventilation effectively purges excess heat build-up during the day and cools the building fabric, especially if it is thermally massive.*<br>*WYG Acoustician has confirmed that the proposed opening schedule are acceptable and in line with the noise requirements.* |

**Table i: Design features to address the cooling hierarchy (London Plan Policy SI4).**

| Cooling Hierarchy | Design Feature | Discussion |
|---|---|---|
| **5. Mechanical measures** | **Dwellings:** Enhanced mechanical ventilation rate up to 4.0 ACH for sensitive noise facades (Block C) and minimum Part F requirements for all other dwellings.<br>**Communal corridors:** Mechanical ventilation rate of 1.5 ACH. | *A mechanical ventilation system being capable of delivering beyond minimum Part F ventilation rates (Confirmed by AWA Consultants)* |
| **6. Active cooling** | There is no requirement for active cooling. A combination of passive measures and background mechanical ventilation in conjunction with natural ventilation have been incorporated to mitigate the overheating risk. | |

# Contents

# 1. INTRODUCTION

**1.1** This document has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development on behalf of the Applicants, Cambridge Road (RBK) LLP, in support of a planning application for the Cambridge Road Estate which comprises Phase 1 in detail and all other Phases in outline. The site is located within the Royal Borough of Kingston upon Thames.

## Site Location

**1.2** The proposed development site at Cambridge Road Estate in the Royal Borough of Kingston upon Thames is approximately 9 hectares and is located to the immediate south of the A2043 Cambridge Road and Hawks Road, as shown in Figure 1 below.

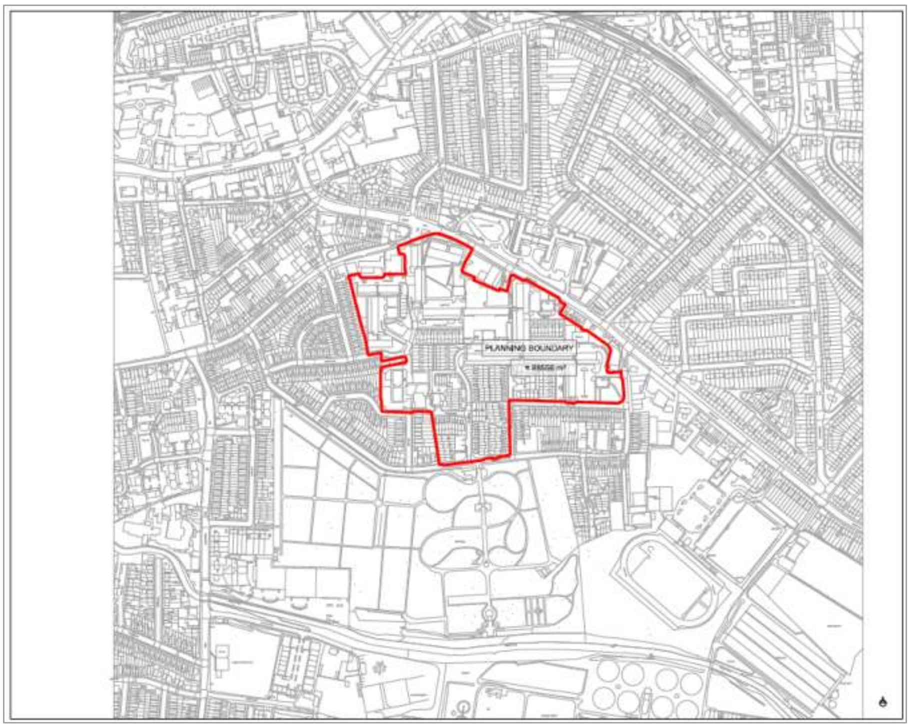


**Figure 1: Site plan Courtesy of Patel Taylor**

**1.3** The land use in the immediate vicinity of the site is predominantly residential and of a domestic suburban character and scale. Cambridge Road Estates was built in the late 60s and early 70s and currently comprises 832 residential homes; Hawks Road Clinic within the northwest of the site; The Bull and Bush Public House and Hotel within the west of the site; and Piper Community Hall within the south of the site. The site also includes small formal and informal play spaces and ground level car parking areas.

## Proposed Development

**1.4** The proposed development is described as follows:

*Hybrid Outline Planning Application for a mixed use development, including demolition of existing buildings and erection of up to 2,170 residential units (Use Class C3), 290sqm of flexible office floorspace (Use Class E), 1,395sqm of flexible retail/commercial floorspace (Use Class E/Sui Generis), 1,250sqm community floorspace (Use Class F2), new publicly accessible open space and associated access, servicing, landscaping and works.*

*Detailed permission is sought for access, layout, scale, appearance and landscaping of Phase 1 for erection of 452 residential units (Use Class C3), 1,250sqm community floorspace (Use Class F2), 290sqm of flexible office floorspace (Use Class E), 395sqm of flexible retail/commercial floorspace (Use Class E/Sui Generis), new publicly accessible open space and associated access, servicing, parking, landscaping works including tree removal, refuse/recycling and bicycle storage, energy centre and works ("the Proposed Development")."*

**1.5** Figure 2 below illustrates the proposed masterplan layout.

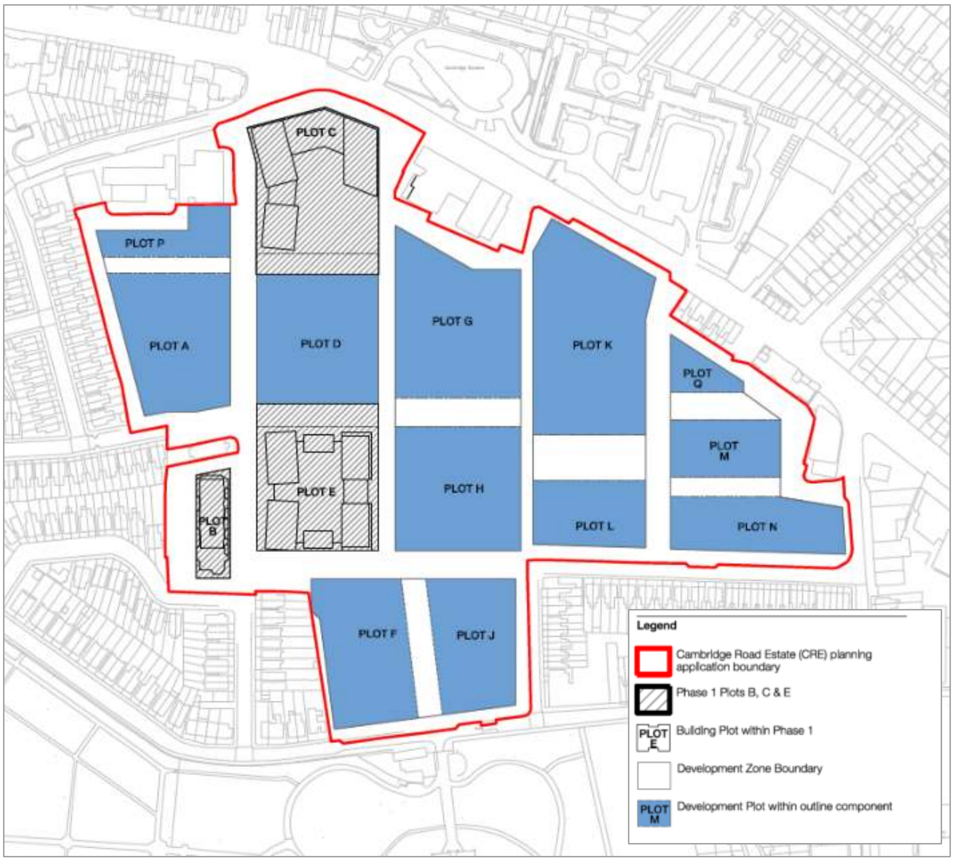


**Figure 2: Parameter Plan (Patel Taylor, October 2020).**

## Overheating and Thermal Comfort

**1.6** Maintaining comfortable thermal comfort conditions in the face of climate change and increasing temperatures is one of the largest challenges to be addressed by designers. The main objective is to achieve thermal comfort and minimise summertime overheating without the use of conventional air conditioning systems, which typically have associated greenhouse gas emissions and impact on the urban heat island effect.

**1.7** Dynamic thermal simulations have been carried out for representative dwellings, to determine whether there is a risk of overheating. Appropriate mitigation measures have been recommended to mitigate the overheating risk and ensure that comfortable thermal conditions are achieved.

# 2. REQUIRED STANDARDS

## Local Policy: Royal Borough of Kingston Upon Thames: Core Strategy and Residential Supplementary Planning Documents

**2.1** The Royal Borough of Kingston Upon Thames' Core Strategy document was adopted in April 2012. The following policies are considered relevant to address overheating:

*__Policy C2 – Climate Change Adaptation__: The Council will ensure that future development takes into consideration the following: Hotter summers and therefore increased cooling demands; Warmer, wetter winters and increased flood risk; Water shortages and drought; Urban heat island effect; and Subsidence.*

*__Policy DM3 – Designing for Changing Climate__: Design proposals should incorporate climate change adaptation measures based on the type and extent of the main changes expected in the local climate throughout the lifetime of the development, this is likely to require a flexible design that can be adapted to accommodate the changing climate e.g. provision of additional shading and cooling.*

**2.2** In addition, the **Residential Supplementary Planning Documents** (Adopted July 2013) sets out passive design principles which will contribute to reduce the likelihood of overheating within Policy Guidance 3 Sustainable Design.

*The __Policy Guidance 3 – Sustainable Design__ states that Developers are encouraged to exceed statutory requirements as set out in current London Plan policy 5.3, the Mayor's Housing SPG, and in Core Strategy Policies DM1 and DM3 with particular attention given to:*

> Minimising energy and CO2 emissions;

> Efficient use of natural resources (including water);

> Design of streets and siting of buildings- orientating homes to maximising passive solar gain or shelter from prevailing winds. Designing a residential development so that houses take advantage naturally occurring conditions or features may be challenging on constrained sites;

> Optimising building density - complementing policy objectives to optimise housing output, resource efficiency should also be promoted by encouraging higher densities in appropriate locations;

> Incorporation of green/blue infrastructure;

> Flood attenuation by sustainable drainage methods;

> Enhancing biodiversity; and

> Promoting local flood growing opportunities.

## Current London Plan (2016)

**2.3** The existing London Plan sets out an integrated economic, environmental, transport and social framework for the development of London. The following key policies are considered relevant to the Proposed Development and this Overheating Assessment.

**2.4** **Policy 5.9 Overheating and Cooling** in the London Plan outlines key policies relevant to the Proposed Development and this Overheating Assessment:

*The Mayor seeks to reduce the impact of the urban heat island effect in London and encourages the design of places and spaces to avoid overheating and excessive heat generation, and to reduce overheating due to the impacts of climate change and the urban heat island effect on an area wide basis. 1. Minimise internal heat generation through energy efficient design;*

*2. Reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration, insulation and green roofs and walls;*

*3. Manage the heat within the building through exposed internal thermal mass and high ceilings;*

*4. Passive ventilation;*

*5. Mechanical ventilation;*

*6. Active cooling systems (ensuring they are the lowest carbon options).*

**2.5** It is expected that dynamic thermal modelling of the overheating risk will be undertaken to support the energy assessment, unless the applicant can demonstrate exceptional circumstances where opportunities for reducing cooling demands via passive measures are constrained.

**2.6** *Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy:*

**2.7** *Major development proposals should demonstrate how the design, materials, construction and operation of the development would minimise overheating and also meet its cooling needs. New development in London should also be designed to avoid the need for energy intensive air conditioning systems as much as possible. Further details and guidance regarding overheating and cooling are outlined in the London Climate Change Adaptation Strategy.*

**2.8** The dynamic thermal modelling should be in addition to any assessment of overheating risk obtained from the Part L Building Regulation compliance tools SAP and SBEM. Evidence of how the development performs against the overheating criteria should be presented along with an outline of the assumptions made (e.g. around internal gains).

## The Intend to Publish London Plan (2019)

**2.9** While not yet adopted, the Intend to Publish London Plan now carries increasing weight. This version of the Intend to Publish London Plan has been reviewed by the Secretary of State and Directions have been issued in respect of some policies but none that relate to the sustainability matters.

**2.10** The following key policy in the Intend to Publish London Plan is considered relevant to the proposed development and this Overheating Assessment:

**2.11** **Policy SI4 Managing Heat Risk** states that development proposals should minimise adverse impacts on urban heat island through design, layout, orientation, materials and the incorporation of green infrastructure and that major development proposals should demonstrate through an energy strategy how they will reduce the potential for internal overheating and reliance on air conditioning systems in accordance with the following cooling hierarchy (Figure 3):

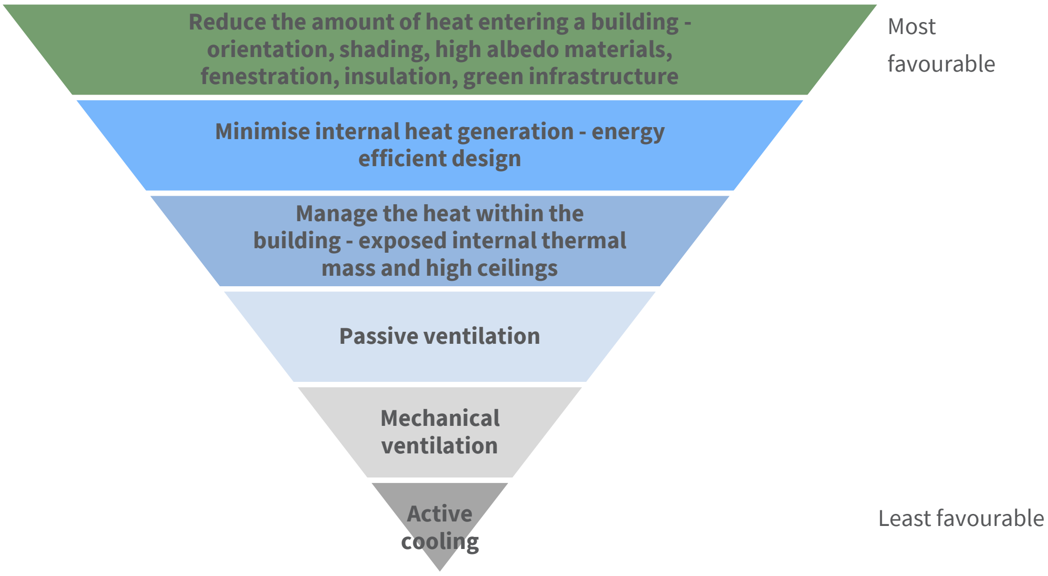


Figure 3: Cooling Hierarchy (Draft London Plan 2019)

**2.12** Low-energy measures should be used to mitigate overheating risk. These include solar shading, building orientation and solar-controlled glazing. Occupant behaviour will also have an impact on overheating risk.

**2.13** Passive ventilation should be prioritised, (accounting for external noise issues and local air quality). The increased use of air conditioning systems is not desirable. If active cooling systems, such as air conditioning systems, are unavoidable, these should be designed to reuse the waste heat they produce.

**2.14** The Draft GLA Guidance on Preparing Energy Assessments (2020), identifies CIBSE TM59 guidance as the most appropriate methodology for the assessment of overheating risk of homes. The Good Home Alliance (GHA) overheating risk tool has also been used by the design team to investigate effective design solution to mitigate the risk of overheating.

## CIBSE TM59 (2017) Assessment Criteria

**2.15** The criteria for the assessment of overheating risk have been specified by the Chartered Institute of Building Services Engineers (CIBSE) in the CIBSE TM59: *Design methodology for the assessment of overheating risk in homes* (2017). CIBSE TM59 is based on CIBSE TM52 and CIBSE Guide A and provides a standardised approach to predicting overheating risk for both naturally and mechanically ventilated residential buildings.

**2.16** The following criteria must be met in order to demonstrate compliance:

> **For living rooms, kitchens and bedrooms:** The indoor operative temperature should not exceed the threshold comfort temperature by 1ºC or more for more than 3 % of occupied hours.

> **For bedrooms only:** To guarantee comfort during the sleeping hours the operative temperature in the bedroom from 10 pm to 7 am should not exceed 26 °C for more than 1% of annual hours.

> **For communal corridors:** The threshold temperature of 28 ºC should not be exceeded for more than 3 % of the total annual hours.

# 3. MODELLING APPROACH

## Unit Selection

**3.1** Dynamic thermal modelling has been undertaken using Design Builder Software (v.6). The performance of the units has been assessed under the CIBSE TM59 guidance and the adaptive thermal comfort model for a primarily natural ventilated scenario.

**3.2** Representative dwelling units with different layouts, sizes, orientation and external shading have been assessed. The selection of the units for overheating risk assessment was based on the following design characteristics:

> Varying proportions of glazed areas;

> Units located in different orientations, on different floor levels and across all blocks;

> Dwellings with varying amounts of cross ventilation, including single and dual aspect units;

> Dwellings with and without external shading from balcony overhangs or surrounding buildings; and

> Units on different facades with and without external noise constraints.

**3.3** Two representative communal corridors, associated with the assessed dwellings, were also selected for overheating assessment. The location and the internal layouts of the dwellings and corridors selected for assessment are presented in Appendix T1.

## Site External Weather Conditions

**3.4** External temperatures and incident solar gains are greatest during summer months, coinciding with periods of lower wind speeds. Solar altitude is also highest during summer months, increasing the effects of façade shading from balcony overhangs and window reveals. Such considerations should be accounted for when designing for overheating risk.

**3.5** The effects of external conditions are vital in an overheating assessment as they influence:

> Solar heat gains (a function of incident direct and diffuse solar radiation and solar altitude); and

> Calculated natural ventilation rates (a function of external temperature, wind directions and speeds).

**3.6** CIBSE Design Summer Year weather data for London Heathrow (representative of lower density urban and suburban areas) has been used for the 2020s, high emissions, 50% percentile scenario as required by CIBSE TM59 and the London Plan.

**3.7** The assessment of overheating risk undertaken using the Design Summer Year 1 (DSY1) weather file, in accordance with the requirements. The final mitigation strategy has also been tested under the more extreme DSY2 and DSY3 weather files and the results are presented in Appendix T2.

## Model Geometry and Local Shading

**3.8** Overshadowing from the building blocks has been taken into account during the simulation, based on the model geometry and the site orientation.

**3.9** Solar control forms an integral part of overheating mitigation strategies. External shading in the form of balconies is applied in most of the façades across the development as part of the design proposals. These were incorporated in the simulation model and are shown in Figure 4.

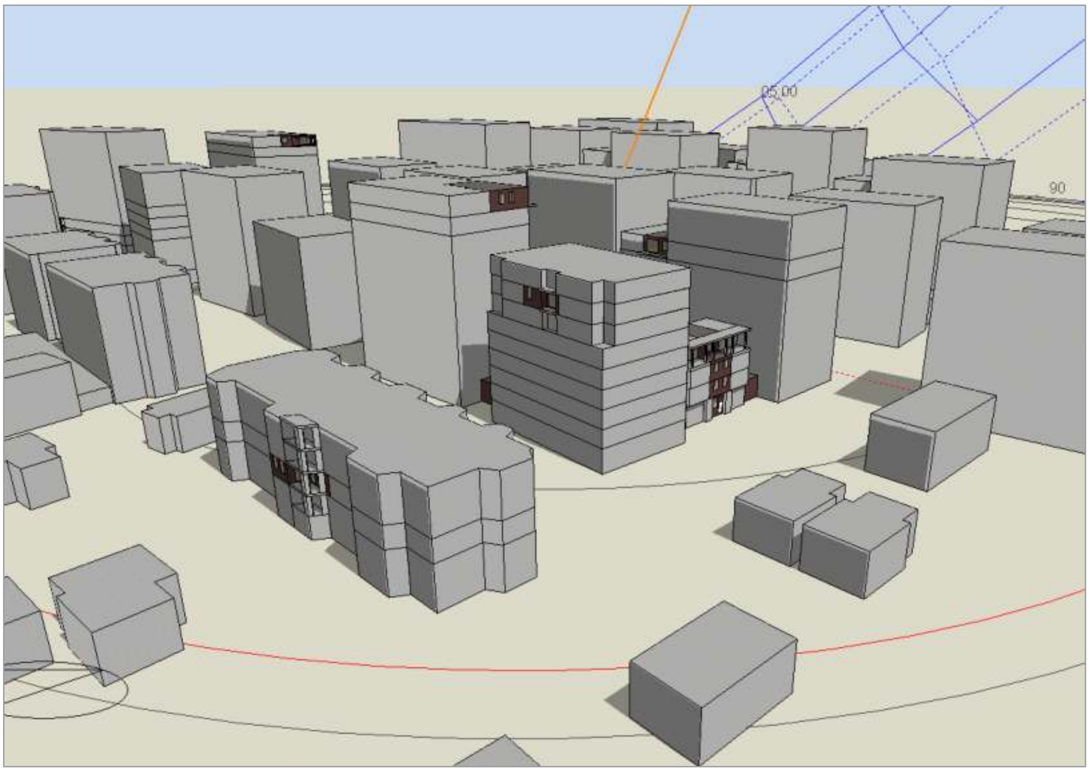


**Figure 4: Design builder simulation model for Blocks B and E, sun path shown for 21st June 12:00 noon BST.**

**3.10** Horizontal shading devices such as balconies and overhangs are more efficient when applied in south oriented façades and during midday when the solar angle is high. Their role in reducing solar gains in the summer period is considered to be paramount.

**3.11** The model has been built to include future phases of the Cambridge Road Estate masterplan as it represents the long-term context for the assessed buildings. It should also be noted that the future phases are in outline and with design and layout determined by parameter plans. This is one way in which they could be delivered.

## Design Modelling Inputs for Dwellings

**3.12** The following modelling inputs (Table 1) have been included in the baseline dynamic thermal simulation, in line with the Energy Statement.

**Table 1: Baseline dynamic thermal modelling design assumptions.**

| Data Input | | | Discussion |
|---|---|---|---|
| **Weather data** | **Location** | CIBSE London Heathrow Design Summer Years (DSYs) for 2020s, high emissions, 50% percentile scenario | *Geographically closest and most representative industry-standard CIBSE weather data file* |
| **Building Fabric Construction details** | **External walls** | 0.17 W/m²K | *As per the Energy Statement* |
| | **Roofs** | 0.13 W/m²K | *As per the Energy Statement* |
| | **Ground floor** | 0.10 W/m²K | *As per the Energy Statement* |
| | **Ceilings/floors** | Assumed to be adiabatic between adjacent floors | *Concrete slabs will add to the thermal capacity of the building*<br>*When dwelling covering the unit above / below heat loss is assumed to be zero* |
| | **Party walls between units and houses** | Assumed to be adiabatic between adjacent dwellings | *Walls adjacent to other units are assumed to be lightweight partitions adjacent units have been included in the dynamic simulation calculations* |
| | **Partitions within units** | Steel-stud partitions | *Assumed thicknesses as per Patel Taylor drawings* |
| | **Internal doors** | 0.90 m width | As per *Patel Taylor drawings* |
| **Windows** | **Windows and Glazed Doors** | U value 1.3 W/m²K | *As per Energy Statement* |
| | **Reveal depth** | External reveal: 112.5 mm<br>Internal reveal: 377.5 mm | *As measured from Patel Taylor drawings* |
| **Infiltration** | **Air Tightness** | 3.0 $m^3$/hr-$m^2$ @50 pascals | *As per the Energy Statement* |
| | **Mechanical ventilation** | Dwellings: Mechanical ventilation to achieve 1.0 ach (depending on unit size up to a maximum of 66.9l/s). | *Assumption made based on a MVHR system that will achieve ventilation rates beyond the minimum Part F requirements.*<br><br>*For more details on ventilation rates refer to Appendix T3.* |

**3.13** The following occupancy schedules and internal gains assumptions (Table 2) have been used, in accordance with CIBSE TM59 guidance.

**Table 2: Occupancy and equipment gains for dwellings (CIBSE TM59).**

| Unit/room type | Occupancy | Equipment Load |
|---|---|---|
| **1-bedroom apartment: living room/kitchen** | 1 person from 9 am to 10 pm; room is unoccupied for the rest of the day | Peak load of 450 W from 6 pm to 8 pm<br>200 W from 8 pm to 10 pm<br>110 W from 9 am to 6 pm and from 10 pm to 12 pm<br>Base load of 85 W for the rest of the day |
| **2-bedroom apartment: living room/kitchen** | 2 people from 9 am to 10 pm; room is unoccupied for the rest of the day | Peak load of 450 W from 6 pm to 8 pm<br>200 W from 8 pm to 10 pm<br>110 W from 9 am to 6 pm and from 10 pm to 12 pm<br>Base load of 85 W for the rest of the day |
| **3-bedroom apartment: living room/kitchen** | 3 people from 9 am to 10 pm; room is unoccupied for the rest of the day | Peak load of 450 W from 6 pm to 8 pm<br>200W from 8 pm to 10 pm<br>110 W from 9 am to 6 pm and from 10 pm to 12 pm<br>Base load of 85 W for the rest of the day |
| **Double bedroom** | 2 people at 70% gains from 11 pm to 8 am, 2 people at full gains from 8 am to 9 am and from 10 pm to 11 pm, 1 person at full gain in the bedroom from 9 am to 10 pm | Peak load of 80 W from 8 am to 11 pm<br>Base load of 10 W during the sleeping hours |
| **Single bedroom** | 1 person at 70% gains from 11 pm to 8 am,<br>1 person at full gains from 8 am to 11 pm | Peak load of 80 W from 8 am to 11 pm<br>Base load of 10 W during sleeping hours |
| **Utility cupboard** | N/A | 10 W on 24/7 |

## Design Modelling Inputs for Communal Corridors

**3.14** The same building fabric details outlined within Table 1 have been used in the modelling of the communal corridor. Occupancy schedules and internal gains assumptions are taken from CIBSE TM59 guidance, while heat losses from communal heating pipework have been provided by AWA consultants (Table 3).

**Table 3: Occupancy and equipment gains for communal corridors (AWA Consultant).**

| Corridor | Element | Occupancy | Equipment Load |
|---|---|---|---|
| **Block B _ Communal corridor on the 4th floor** | **South corridor, ceiling Void** | N/A | 124 W |
| | **North corridor ceiling Void** | N/A | 248 W |
| **Block E1 _ Communal corridor on the 11th floor** | **Ceiling Void** | N/A | 233 W |
| **All corridors** | **Mechanical Risers** | N/A | 20.75 W |

**Table 3: Occupancy and equipment gains for communal corridors (AWA Consultant).**

| **Corridor** | **Element** | **Occupancy** | **Equipment Load** |
|---|---|---|---|
| | | | (calculated based on the heat losses per meter) |
| | **Lighting** | N/A | 0.0 W (PIR sensors) |

# 4. AIR QUALITY AND NOISE CONSTRAINTS

**4.1** The Air Quality Assessment has been undertaken by Ensafe Consultants (presented in Chapter 7 of the ES submitted in support of the planning application). It has been confirmed that only the ground floor level of the façades facing Cambridge Road on Block C will be above national air quality objectives for the pollutant Nitrogen Dioxide. Nitrogen Dioxide concentrations are lower at elevated heights due to increased distance from emission sources, such as roads. Therefore, predicted concentrations at heights above ground floor level are considered to be acceptable and windows do not need to be sealed and can be used to ventilate the spaces. This is valid for all blocks B, C, and E part of the detailed design.

**4.2** WYG Acoustics have undertaken an Acoustic Assessment for the proposed development (Cambridge Road Estate, Nosie Assessment, WYG, October 2020). An assessment of the predicted noise level based on noise risk categories set out within the Association of Noise Consultants *Acoustics, Ventilation and Overheating Residential Design Guide* (AVO Guide) (January 2020) was also provided.

**4.3** Figure 5 shows the facades affected by external noise constraints in block C. The findings indicate that northern and eastern facades of Blocks C1 & C2 fall within AVO noise risk category 'high' and western facades fall within AVO noise risk category 'medium' during both day and night-time.

**4.4** All other facades in Block C as well as all other blocks part of the detailed planning application (Blocks B and E) fall under 'low' and 'negligible' noise risk category.

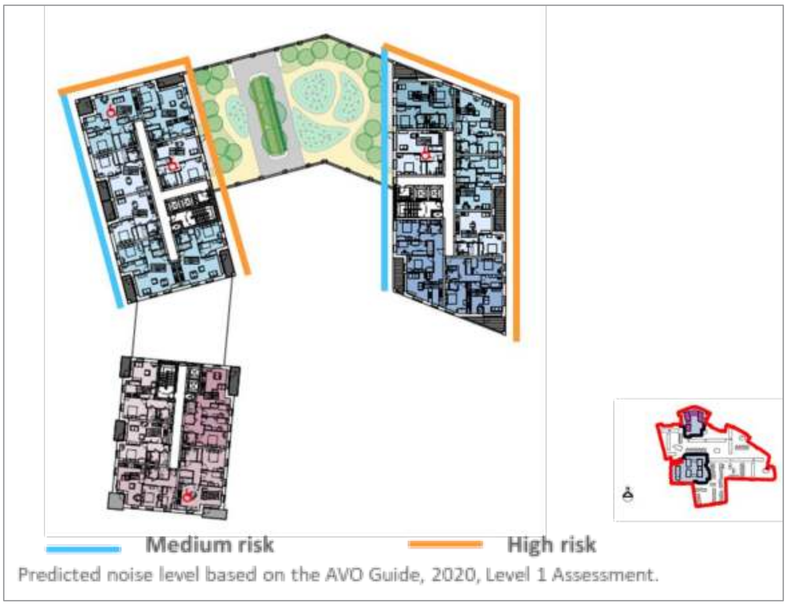


**Figure 5: Diagram of the results of the noise modelling in line with AVO Guide risk assessment. (Patel Taylor 1st floor plan drawings with the noise information provided by WYG)**

**4.5** Window opening schedules (Table 4) have therefore been adapted to allow natural ventilation to mitigate overheating without exposing residents to unacceptable noise levels and air quality issues.

**Table 4: Proposed natural ventilation strategy for dwellings based on the noise constraints**

| Noise risk category | Room | Occupied Hours (TM59) | Window opening schedule | Discussion |
|---|---|---|---|---|
| **Non-sensitive noise facades (the majority of the blocks)** | **Kitchen / Living areas** | 09:00-22:00 | Kitchen/Living room: 9:00-22:00 | *Windows open during the day in the kitchen/living rooms and during the night in the bedrooms* |
| | **Bedrooms** | 24/7 (sleeping hours 22:00-07:00) | Bedrooms: 24/7 | |
| **Sensitive noise facades (Facades at medium and high noise category on Block C)** | **Kitchen / Living areas** | 09:00-22:00 | Kitchen/Living room: 22:00-9:00 | *Windows open when the spaces are not in use.*<br>*Bedrooms require windows to be open for some hours during the hottest nights of the year to cool down the space.*<br>*Ensafe and WYG Consultants confirmed that the proposed strategy is acceptable and in line with noise and air quality criteria.* |
| | **Bedrooms** | 24/7 (sleeping hours 22:00-07:00) | Bedrooms: 07:00-02:00 | |

**4.6** Windows are simulated to be open when the internal temperature exceeds 22 °C and the external temperature is lower than the internal temperature.

# 5. MITIGATION STRATEGY

**5.1** It is important to identify potential overheating risk early on in the design process and incorporate as many suitable passive design measures as possible. Particularly when the site presents external constraints such as noise issues that can limit the use of openable windows to ventilate the habitable spaces.

**5.2** The GHA overheating early stage risk tool have been employed during the design process to investigate design solution to minimise the risk of overheating. Appendix T4 presents the GHA scoresheets for the blocks with and without noise constraints of Phase 1.

## Proposed passive measures

**5.3** The following passive design measures have been incorporated in accordance with the London Plan Cooling Hierarchy:

> Highly efficient fabric envelope and high efficiency building services heating system, lighting and appliances are proposed in all dwellings to reduce internal gains;

> High performance solar control glazing with a g-value ranging from 0.50  to 0.45. This has been balanced to mitigate overheating risk whilst achieving fabric energy efficiency targets, noise constraints and natural daylight provision;

> Openable parts of windows have been maximised and sized to allow enhanced levels of natural ventilation above minimum Part F requirements following GHA overheating recommendations;

> Window openability has been maximised by choosing a type of window that allows to be fully open 90-degrees outwards;

> External shading is provided to large glazed windows in form of balconies across all blocks to control solar gains;

> A concrete floor slab provides some thermal capacity to absorb excessive heat within the building;

> Internal reflective blinds (70% solar reflectance) are employed in the bedrooms on the sensitive noise facades to control solar gains and mitigate residual risk of overheating (Appendix T5)

> Enhanced mechanical ventilation rates up to 4.0 air changes per hour to assist in mitigating the risk of overheating for the units on the sensitive noise façades in Block C.

# 6. SUMMARY OF RESULTS

6.1 This chapter summarises the results given by running dynamic thermal simulations for the buildings under the current design summer year (1989) for the 2020s high emission, 50% percentile scenario, as required by CIBSE TM59 and planning policies.

## Dwellings

6.2 Results presented in Table 5 indicate that all assessed units demonstrate an acceptable risk of overheating in accordance with CIBSE TM59.

**Table 5: Overheating Results for DSY1 2020s - TM59**

| Unit | Room | TM59 Criterion A: Hours of exceedance (pass<3%) | TM59 Criterion B: Bedroom temperature hours >26°C (pass<32) | Overall compliance with TM59 |
|---|---|---|---|---|
| | | % Hours of overheating | Hours of overheating | |
| B1.2.9 2B4P | Bedroom 1 | 0.00 | 18.83 | Pass |
| | Bedroom 2 | 0.02 | 10.83 | Pass |
| | Living/Kitchen/Dining | 0.00 | N/A | Pass |
| C1.1.5 2B3P | Bedroom 1 Single | 0.00 | 20.33 | Pass |
| | Bedroom 2 | 0.02 | 19.33 | Pass |
| | Living/Kitchen/Dining | 0.00 | N/A | Pass |
| C2.11.6 3B5P | Bedroom 1 | 0.00 | 14.50 | Pass |
| | Bedroom 2 | 0.00 | 30.83 | Pass |
| | Bedroom 3 Single | 0.00 | 31.33 | Pass |
| | Living/Kitchen/Dining | 0.10 | N/A | Pass |
| C3.5.5 3B4P | Bedroom 1 | 0.00 | 17.83 | Pass |
| | Bedroom 2 Single | 0.00 | 18.17 | Pass |
| | Bedroom 3 Single | 0.00 | 16.33 | Pass |
| | Living/Kitchen/Dining | 0.00 | N/A | Pass |
| E1.11.1 3B6P | Bedroom 1 | 0.00 | 22.83 | Pass |
| | Bedroom 2 | 0.00 | 25.83 | Pass |
| | Bedroom 3 | 0.00 | 19.00 | Pass |
| | Living/Kitchen/Dining | 1.43 | N/A | Pass |
| E3.7.2 3B5P | Bedroom 1 | 0.00 | 11.83 | Pass |
| | Bedroom 2 | 0.00 | 14.83 | Pass |
| | Bedroom 3 Single | 0.05 | 19.33 | Pass |

**Table 5: Overheating Results for DSY1 2020s - TM59**

| Unit | Room | TM59 Criterion A: Hours of exceedance (pass<3%) | TM59 Criterion B: Bedroom temperature hours >26°C (pass<32) | Overall compliance with TM59 |
|---|---|---|---|---|
| | | % Hours of overheating | Hours of overheating | |
| E3.7.2 3B5P | Living/Kitchen/Dining | 2.00 | N/A | Pass |
| E4.7.3 1B2P | Bedroom 1 | 0.06 | 22.67 | Pass |
| | Living/Kitchen/Dining | 0.75 | N/A | Pass |
| House 1F E6.1.2 | Bedroom 1 Single | 0.00 | 8.67 | Pass |
| | Living Room | 0.00 | N/A | Pass |
| House 2F E6.2.2 | Bedroom 1 Single | 0.00 | 7.67 | Pass |
| | Bedroom 2 Single | 0.00 | 8.50 | Pass |
| | Bedroom 3 Single | 0.00 | 9.00 | Pass |
| House 3F E6.3.2 | Bedroom 4 | 0.00 | 7.33 | Pass |
| House GF E6.0.2 | Kitchen | 0.00 | N/A | Pass |

**6.3** The more extreme weather files DSY2, DSY3 have also been tested and results are presented in Appendix T2.

**6.4** Additionally, the results without the use of internal blinds for the dwellings on the noisy facades in Block C are shown in Appendix T6.

## Communal Corridors

**6.5** Under CIBSE TM59 (2017) guidance, the maximum recommended temperature of 28 $^{0}$C should not be exceeded for more than 3 % of the total annual hours for the communal corridor areas.

**6.6** With a mechanical extract ventilation system achieving air flow rate of at least 1.5 air changes per hour (ach) the corridors temperatures remain below the 3% target as shown in Table 6.

**Table 6: TM59 overheating results for the assessed corridor with mechanical ventilation of 1.5 ACH**

| Corridors | | TM59 Overheating Criterion (≤ 3% over 28°C) | Overall compliance with TM59 |
|---|---|---|---|
| Block B 4F Corridor | Corridor North | 0.00 | Pass |
| | Corridor South | 0.00 | Pass |
| Block E 11F Corridor | | 0.53 | Pass |

**6.7** Results for DSY2 and DSY3 extreme weather files presented in Appendix T2, indicate that the proposed ventilation strategy be effective in achieving thermal comfort in accordance with the CIBSE TM59 criterion.

# 7. CONCLUSION

**7.1** This report details the methodology and findings of the dynamic overheating assessment of representative dwellings in support of the Hybrid planning application for the proposed Cambridge Road Estate by Cambridge Road (RBK) LLP in the Royal Borough of Kingston upon Thames. This document outlines the overheating mitigation strategy for Blocks B, C, and E of Phase 1 (the detailed component) of the Cambridge Road Estate masterplan scheme.

**7.2** The analysis has been undertaken in line with the current London Plan (2016) Policy 5.9 *Overheating and cooling*, the Intend to Publish London Plan (2019) Policy SI4: *Managing heat risk* and the Royal Borough of Kingston upon Thames overheating policies.

**7.3** Dwellings have been selected for the overheating assessment based on design characteristics that establish them as representative of the overall proposed scheme. This selection of dwellings includes consideration of varying floors and of different orientations. Air quality and noise constraints have also been considered as part of the overheating strategy in accordance with Intend to be Publish London Plan Policy D3 *Optimising site capacity through the design-led approach (3.3.9)*.

**7.4** For the purposes of this report, it is assumed that dwellings will utilise openable windows as the primary means of ventilation, with a background mechanical ventilation system. Passive measures, for example, high energy efficiency, solar control glazing, and external shading in form of balconies have been explored and adopted as far as practicable to avoid the need for comfort cooling.

**7.5** The performance of the dwellings has been assessed against the Charted Institute of Building Services Engineers (CIBSE) guidance CIBSE TM59: *Design Methodology for the Assessment of Overheating Risk in Homes* (2017). This dynamic overheating assessment of representative dwellings demonstrates that an acceptable overheating risk is achieved.

**7.6** All dwellings assessed demonstrate an acceptable risk of overheating under mandatory Design Summer Year (DSY 1) weather conditions. The results are based on some key design features that follow the London Plan 'cooling hierarchy', as shown in Table 7.

**7.7** Similar overheating results are expected for the other blocks which are part of the Outline. However additional dynamic overheating modelling will be carried out for each future Reserved Matter Applications to ensure the risk of overheating is reduced.

**Table 7: Design features to address the cooling hierarchy (London Plan Policy SI4).**

| Cooling Hierarchy | Design Feature | Discussion |
|---|---|---|
| **1. Reduce the amount of heat entering the building** | Highly efficient building fabric and air tightness standards. | *As per Energy Statement* |

| **Table 7: Design features to address the cooling hierarchy (London Plan Policy SI4).** | | |
|---|---|---|
| **Cooling Hierarchy** | **Design Feature** | **Discussion** |
| | Solar control glazing with g-value of 0.45 for the apartments and 0.50 for the houses (Blocks C & E). | *A low G-value reduces the solar gains, therefore assists in mitigation of overheating. However, it has implications on operational carbon emissions, fabric energy efficiency and internal daylight levels and has therefore been optimised to balance all aspects as far as possible.* |
| | **External shading**: Balcony overhangs across all blocks are included in the model as per design proposals.<br>**Internal shading:** Solar reflective blinds (70% solar reflectance) in all bedrooms on the noisy facades in blocks C1&C2. | *External shading is considered one of the most effective methods for solar control and overheating mitigation.*<br>*When external shading cannot be used the use of internal blinds can help to reduce internal solar gains.* |
| **2. Minimise internal heat generation** | Energy efficient design of building services including communal heating pipework. | |
| **3. Manage the heat** | A concrete 225mm slab has been assumed between dwellings. The thermal mass of this will help reduce the risk of overheating by absorbing heat during the daytime. | |
| **4. Natural ventilation** | **Non-sensitive noise facades:**<br>Windows and glazed doors are assumed fully openable during occupied hours.<br>**Window schedules:**<br>Kitchen/Living Rooms: 9:00-22:00<br>Bedrooms: 24/7 (Space is considered used as study/home office during the day)<br>**Sensitive noise facades:**<br>Windows and glazed doors are assumed openable when the spaces are not in use to limit resident's exposure to noise. Bedrooms will require windows to be open for some hours during the hottest nights of the summer to reduce the risk of overheating.<br>**Window schedules:** | *Windows are simulated to be open when internal temperature exceeds 22°C and when external temperature is lower than the internal temperature: $T_{indoor} > 22°C$, $T_{outdoor} < T_{indoor}$*<br>*Night-time ventilation effectively purges excess heat build-up during the day and cools the building fabric, especially if it is thermally massive.*<br>*WYG Acoustician has confirmed that the proposed opening schedule are acceptable and in line with the noise requirements.* |

| Table 7: Design features to address the cooling hierarchy (London Plan Policy SI4). | | |
|---|---|---|
| **Cooling Hierarchy** | **Design Feature** | **Discussion** |
| | Kitchen/Living Rooms: 22:00-09:00<br>Bedrooms: 07:00-01:00 | |
| **5. Mechanical measures** | **Dwellings:** Enhanced mechanical ventilation rate up to 4.0 ACH for sensitive noise facades (Block C) and minimum Part F requirements for all other dwellings.<br>**Communal corridors:** Mechanical ventilation rate of 1.5 ACH. | *A mechanical ventilation system being capable of delivering beyond minimum Part F ventilation rates (Confirmed by AWA Consultants)* |
| **6. Active cooling** | There is no requirement for active cooling. A combination of passive measures and background mechanical ventilation in conjunction with natural ventilation have been incorporated to mitigate the overheating risk. | |

# APPENDICES

## Appendix T1
Assessed Dwellings and Corridor Internal Layouts

## Appendix T2
Results of DSY2 and DSY3 Weather Scenarios

## Appendix T3
Dwellings mechanical ventilation rates

## Appendix T4
GHA Early Stage Overheating Risk Tool Scoresheet

## Appendix T5
Blinds and enhanced MVHR mark-up

## Appendix T6
Results of DSY 1 without blinds

# APPENDIX T1

## Assessed Dwellings and Corridor Internal Layouts

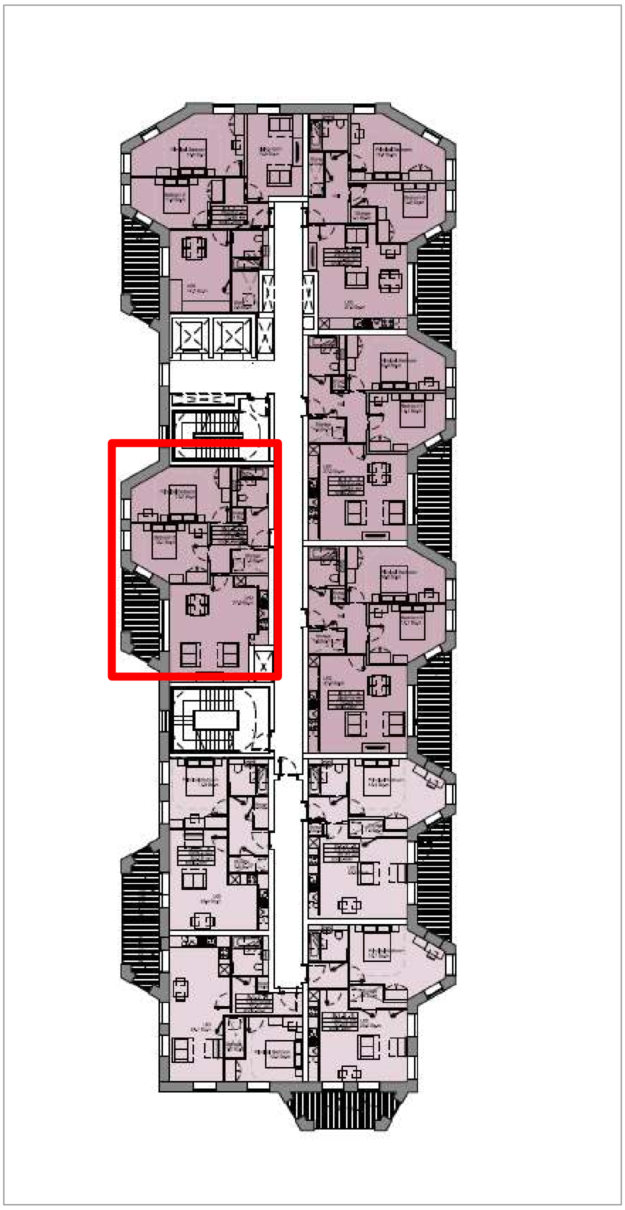


**Figure T1.1. Block B, 2nd floor selected middle floor 2bed dwelling facing west (Patel Taylor drawings 21.09.2020).**

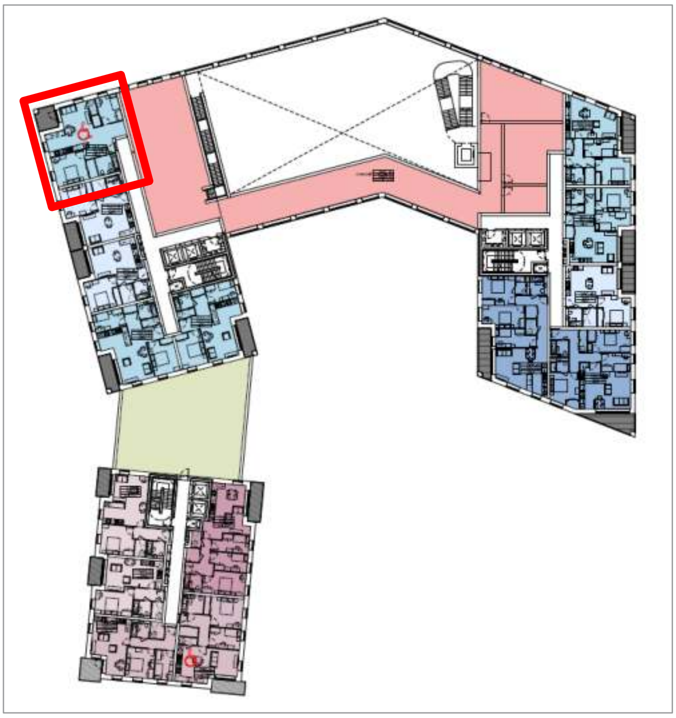


Figure T1.2. Block C, 1st floor selected 2bed dwelling on the nosy façade (Patel Taylor drawings 21.09.2020).

Figure T1.3. Block C, 5th floor selected 3Bed dwelling on the middle level (Patel Taylor drawings 21.09.2020).

Figure T1.4. Block C, 11th floor selected 3bed dwelling on the top level (Patel Taylor drawings 21.09.2020).

**Figure T1.5. Block E, ground floor level selected Maisonette facing south (Patel Taylor drawings 21.09.2020).**

Figure T1.6. Block E, 7th level selected 1bed dwelling facing west on the middle level and top floor dual-aspect 3Bed dwelling (Patel Taylor drawings 21.09.2020).

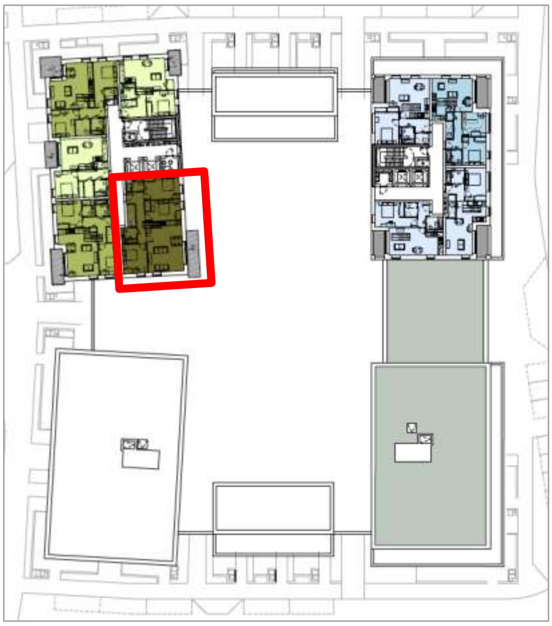


Figure T1.7. Block E, 11th level selected 3bed south-east dwelling top floor dual-aspect (Patel Taylor drawings 21.09.2020).

**Figure T1.7. Block B 4th floor, middle-floor communal Corridor (Patel Taylor drawings 21.09.2020).**

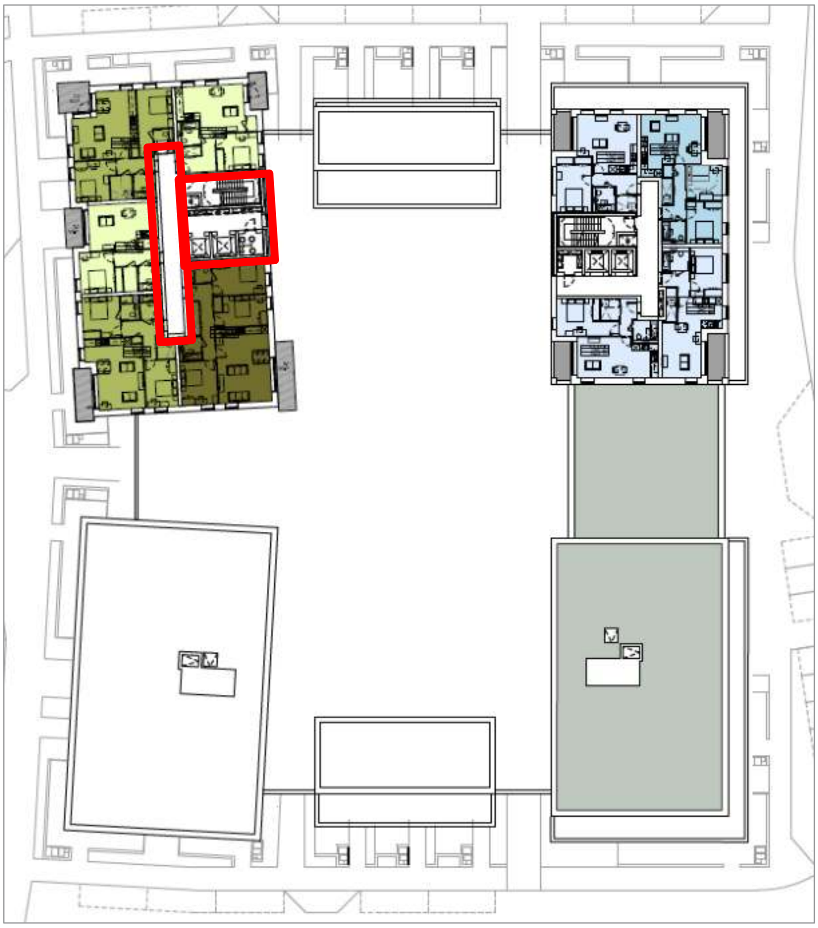


Figure T1.8. Block E 11th floor, top floor communal Corridor (Patel Taylor drawings 21.09.2020).

# APPENDIX T2

## Results of DSY2 and DSY3 Weather Scenarios

Based on the CIBSE TM59 guidance, achieving compliance with the DSY1 (Design Summer Year) file most appropriate for the site location for the 2020s, high emissions, 50% percentile scenario is mandatory.

Further weather scenarios can be tested to explore the performance of the design under extreme weather events (e.g. heatwaves and prolonged warmth). Meeting the criteria for the DSY2 and DSY3 weather files can be challenging and therefore the CIBSE Guidance sets out that where compliance criteria are not met, the assessment should demonstrate how the risk of overheating has been reduced as far as practical.

The overheating mitigation measures for the proposed development are set out in chapter five of this report.

The results of the overheating assessment for the DSY2 and DSY3 weather files with the current overheating mitigation strategy are presented in Tables T2.1 to T2.4.

**Table T2.1: Dwellings TM59 overheating results for DSY2 2020s**

| Unit | Room | TM59 Criterion A: Hours of exceedance (pass<3%) | TM59 Criterion B: Bedroom temperature hours >26°C (pass<32) | Overall compliance with TM59 |
|---|---|---|---|---|
| | | % Hours of overheating | Hours of overheating | |
| B1.2.9 2B4P | Bedroom 1 | 0.06 | 43.00 | Fail |
| | Bedroom 2 | 0.32 | 25.50 | Pass |
| | Living/Kitchen/Dining | 0.46 | N/A | Pass |
| C1.1.5 2B3P | Bedroom 1 Single | 0.33 | 55.17 | Fail |
| | Bedroom 2 | 0.45 | 53.83 | Fail |
| | Living/Kitchen/Dining | 0.48 | N/A | Pass |
| C2.11.6 3B5P | Bedroom 1 | 0.15 | 35.67 | Fail |
| | Bedroom 2 | 0.13 | 68.50 | Fail |
| | Bedroom 3 Single | 0.27 | 64.00 | Fail |
| | Living/Kitchen/Dining | 1.06 | N/A | Pass |
| C3.5.5 3B4P | Bedroom 1 | 0.10 | 48.67 | Fail |
| | Bedroom 2 Single | 0.34 | 46.00 | Fail |
| | Bedroom 3 Single | 0.16 | 44.50 | Fail |
| | Living/Kitchen/Dining | 0.98 | N/A | Pass |
| E1.11.1 3B6P | Bedroom 1 | 0.25 | 49.17 | Fail |
| | Bedroom 2 | 0.21 | 45.50 | Fail |

**Table T2.1: Dwellings TM59 overheating results for DSY2 2020s**

| Unit | Room | TM59 Criterion A: Hours of exceedance (pass<3%) | TM59 Criterion B: Bedroom temperature hours >26°C (pass<32) | Overall compliance with TM59 |
|---|---|---|---|---|
| | | % Hours of overheating | Hours of overheating | |
| | Bedroom 3 | 0.00 | 39.33 | Fail |
| | Living/Kitchen/Dining | 2.31 | N/A | Pass |
| E3.7.2 3B5P | Bedroom 1 | 0.02 | 28.00 | Pass |
| | Bedroom 2 | 0.00 | 34.00 | Fail |
| | Bedroom 3 Single | 0.40 | 41.67 | Fail |
| E3.7.2 3B5P | Living/Kitchen/Dining | 2.39 | N/A | Pass |
| E4.7.3 1B2P | Bedroom 1 | 0.59 | 52.50 | Fail |
| | Living/Kitchen/Dining | 1.66 | N/A | Pass |
| House GF E6.0.2 | Kitchen | 0.00 | N/A | Pass |
| House 1F E6.1.2 | Bedroom 1 Single | 0.02 | 25.67 | Pass |
| | Living Room | 0.00 | N/A | Pass |
| House 2F E6.2.2 | Bedroom 1 Single | 0.00 | 28.33 | Pass |
| | Bedroom 2 Single | 0.00 | 20.33 | Pass |
| | Bedroom 3 Single | 0.00 | 21.67 | Pass |
| House 3F E6.3.2 | Bedroom 4 | 0.00 | 22.17 | Pass |

**Table T2.2: Corridor TM59 overheating results for DSY2 2020s**

| Corridors | | TM59 Overheating Criterion (≤ 3% over 28°C) | Overall compliance with TM59 |
|---|---|---|---|
| Block B 4F Corridor | Corridor North | 0.20 | Pass |
| | Corridor South | 0.57 | Pass |
| Block E 11F Corridor | | 1.53 | Pass |

**Table T2.3: Dwellings: TM59 overheating results for DSY3 2020s**

| Unit | Room | TM59 Criterion A: Hours of exceedance (pass<3%) | TM59 Criterion B: Bedroom temperature hours >26°C (pass<32) | Overall compliance with TM59 |
|---|---|---|---|---|
| | | % Hours of overheating | Hours of overheating | |
| B1.2.9 2B4P | Bedroom 1 | 0.18 | 69.83 | Fail |
| | Bedroom 2 | 0.76 | 36.50 | Fail |
| | Living/Kitchen/Dining | 1.05 | N/A | Pass |
| C1.1.5 2B3P | Bedroom 1 Single | 0.17 | 86.00 | Fail |
| | Bedroom 2 | 0.56 | 82.67 | Fail |
| | Living/Kitchen/Dining | 0.25 | N/A | Pass |
| C2.11.6 3B5P | Bedroom 1 | 0.00 | 60.00 | Fail |
| | Bedroom 2 | 0.00 | 86.67 | Fail |
| | Bedroom 3 Single | 0.07 | 79.67 | Fail |
| | Living/Kitchen/Dining | 0.79 | N/A | Pass |
| C3.5.5 3B4P | Bedroom 1 | 0.00 | 67.00 | Fail |
| | Bedroom 2 Single | 0.07 | 62.33 | Fail |
| | Bedroom 3 Single | 0.00 | 59.83 | Fail |
| | Living/Kitchen/Dining | 0.89 | N/A | Pass |
| E1.11.1 3B6P | Bedroom 1 | 0.00 | 80.67 | Fail |
| | Bedroom 2 | 0.03 | 59.17 | Fail |
| | Bedroom 3 | 0.00 | 51.83 | Fail |
| | Living/Kitchen/Dining | 4.53 | N/A | Fail |
| E3.7.2 3B5P | Bedroom 1 | 0.00 | 40.17 | Fail |
| | Bedroom 2 | 0.00 | 44.50 | Fail |
| | Bedroom 3 Single | 0.82 | 76.17 | Fail |
| E3.7.2 3B5P | Living/Kitchen/Dining | 4.53 | N/A | Fail |
| E4.7.3 1B2P | Bedroom 1 | 1.47 | 79.33 | Fail |
| | Living/Kitchen/Dining | 3.57 | N/A | Fail |
| House GF E6.0.2 | Kitchen | 0.00 | N/A | Pass |
| House 1F E6.1.2 | Bedroom 1 Single | 0.00 | 35.00 | Fail |
| | Living Room | 0.00 | N/A | Pass |
| House 2F E6.2.2 | Bedroom 1 Single | 0.00 | 33.83 | Fail |
| | Bedroom 2 Single | 0.00 | 36.50 | Fail |
| | Bedroom 3 Single | 0.00 | 38.67 | Fail |
| House 3F E6.3.2 | Bedroom 4 | 0.00 | 36.17 | Fail |

**Table T2.4: Corridor TM59 overheating results for DSY3 2020s**

| Corridors | | TM59 Overheating Criterion (≤ 3% over 28°C) | Overall compliance with TM59 |
|---|---|---|---|
| Block B 4F Corridor | Corridor North | 0.27 | Pass |
| | Corridor South | 0.78 | Pass |
| Block E 11F Corridor | | 2.62 | Pass |

# APPENDIX T3

## Dwelling mechanical ventilation rates

Minimum Part F ventilation rates have been calculated and presented in the Table T3.1a-b below. A maximum of 4.0 ach beyond the minimum Part F ventilation rates is required to assist in overheating mitigation for the dwellings on the sensitive noise façades of Block C (Table T3.2).

**Table T3.1a: Capacity of mechanical system for Minimum Part F requirements**

| **Dwelling** | **B1.2.9 - 2bed** | **C1.1.5 - 2 bed** | **C3.5.5 - 3bed** | **C2.11.6-3bed** | **E4.7.3-1bed** | |
|---|---|---|---|---|---|---|
| **Floor Area ($m^2$)** | 71.67 | 72.16 | 77.58 | 94.96 | 50.43 | $m^2$ |
| **Storey height (m)** | 2.5 | 2.5 | 2.5 | 2.5 | 2.5 | m |
| **Volume ($m^3$)** | 179.175 | 180.4 | 193.95 | 237.4 | 126.075 | $m^3$ |
| **Minimum high rate (l/s)** | | | | | | |
| Kitchen | 13 | 13 | 13 | 13 | 13 | l/s |
| Utility cupboard | 8 | 8 | 8 | 8 | 8 | l/s |
| Bathroom 1 | 8 | 8 | 8 | 8 | 8 | l/s |
| Bathroom 2 | | 8 | | 8 | | l/s |
| Toilet | | | | | | l/s |
| Boost rate (l/s)* | 29 | 37 | 29 | 37 | 29 | l/s |
| | | | | | | |
| Whole dwelling ventilation rate ($m^3$/hr) | 104.4 | 133.2 | 104.4 | 133.2 | 104.4 | $m^3$/hr |
| Air change Rate (ach) | **0.58** | **0.74** | **0.54** | **0.56** | **0.83** | ach |

*** Maximum whole dwelling extract ventilation rate**

**Table T3.1b: Capacity of mechanical system for Minimum Part F requirements**

| **Dwelling** | **E3.7.2 -3 bed** | **E1.11.1-3bed** | **E6.0.2 House** | | | |
|---|---|---|---|---|---|---|
| **Floor Area ($m^2$)** | 87.06 | 94.96 | 160.6 | | | $m^2$ |
| **Storey height (m)** | 2.5 | 2.5 | 2.5 | | | m |
| **Volume ($m^3$)** | 217.65 | 237.4 | 270.08 | | | $m^3$ |
| **Minimum high rate (l/s)** | | | | | | |
| Kitchen | 13 | 13 | 13 | | | l/s |
| Utility cupboard | 8 | 8 | 8 | | | l/s |
| Bathroom 1 | 8 | 8 | 16 | | | l/s |
| Bathroom 2 | 8 | 8 | 16 | | | l/s |
| Toilet | | | | | | l/s |
| Boost rate (l/s)* | 37 | 37 | 53 | | | l/s |
| | | | | | | |
| Whole dwelling ventilation rate ($m^3$/hr) | 133.2 | 133.2 | 190.8 | | | $m^3$/hr |
| Air change Rate (ach) | **0.61** | **0.56** | **0.71** | | | ach |

*** Maximum whole dwelling extract ventilation rate**

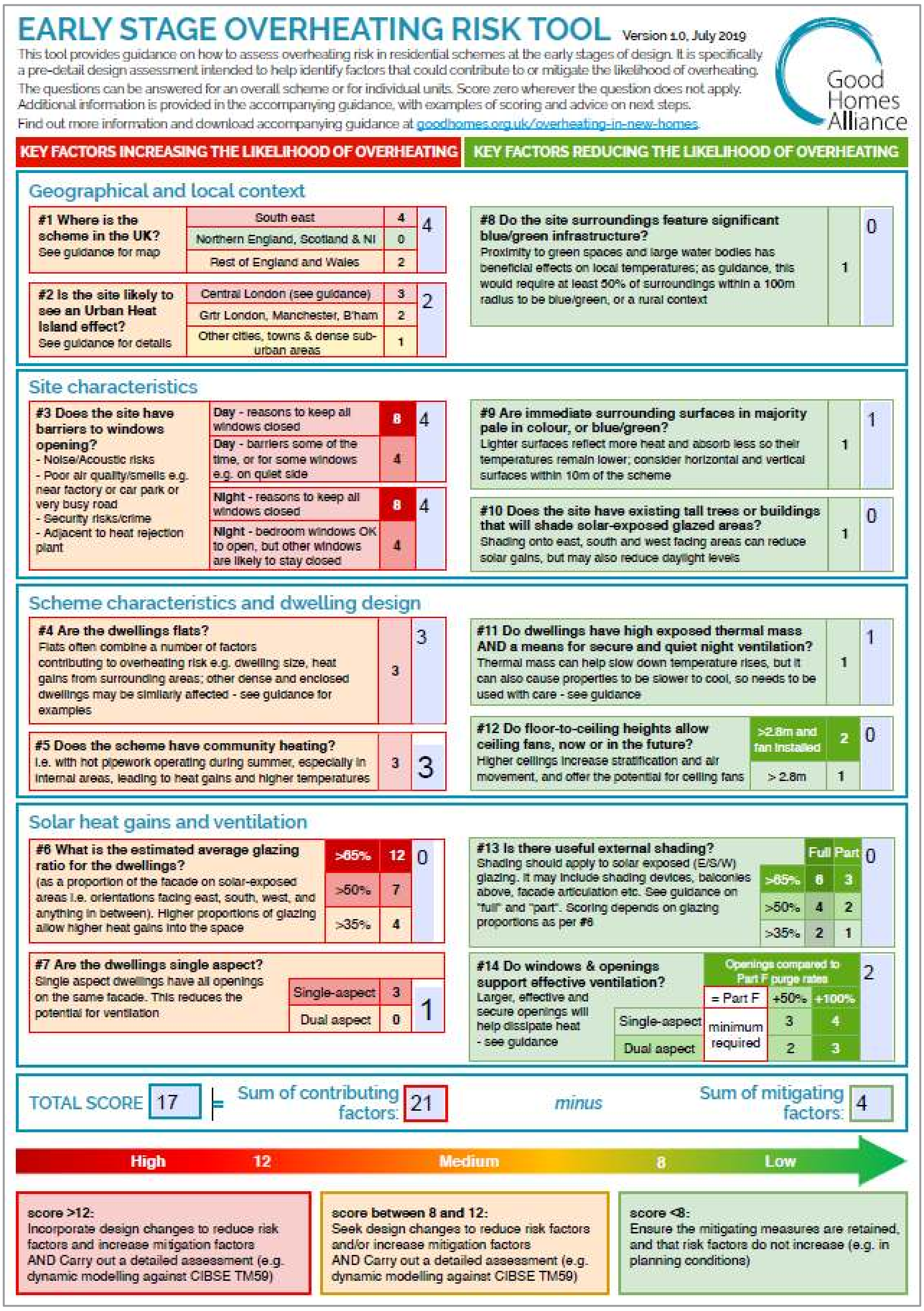
**Table T3.2: Capacity of mechanical system for 4.0 ACH on sensitive noise facades**

| **Dwelling** | **C1.1.5 - 1 bed** | **C2.11.6- 3bed** | |
|---|---|---|---|
| **Floor Area ($m^2$)** | 72.16 | 94.96 | $m^2$ |
| **Storey height (m)** | 2.5 | 2.5 | m |
| **Volume ($m^3$)** | 180.4 | 237.4 | $m^3$ |
| **Minimum high rate (l/s)** | | | |
| Kitchen | 13 | 13 | l/s |
| Utility cupboard | 8 | 8 | l/s |
| Bathroom 1 | 8 | 8 | l/s |
| Bathroom 2 | 8 | 8 | l/s |
| Toilet | | | l/s |
| Boost rate (l/s)* | 200.4 | 263.8 | l/s |
| | | | |
| Whole dwelling ventilation rate ($m^3$/hr) | 721.6 | 949.6 | $m^3$/hr |
| Air change Rate (ach) | **4.00** | **4.00** | ach |

*** Maximum whole dwelling extract ventilation rate**

# APPENDIX T4

## GHA Early Stage Overheating Risk Tool Scoresheet



**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.

Good Homes Alliance

**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 | 4 |
|---|---|---|---|
| | Northern England, Scotland & NI | 0 | |
| | Rest of England and Wales | 2 | |

| **#2 Is the site likely to see an Urban Heat Island effect?** See guidance for details | Central London (see guidance) | 3 | 2 |
|---|---|---|---|
| | Grtr London, Manchester, B'ham | 2 | |
| | Other cities, towns & dense sub-urban areas | 1 | |

| **#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 | 0 |
|---|---|---|

**Site characteristics**

| **#3 Does the site have barriers to windows opening?**<br>- Noise/Acoustic risks<br>- Poor air quality/smells e.g. near factory or car park or very busy road<br>- Security risks/crime<br>- Adjacent to heat rejection plant | Day - reasons to keep all windows closed | 8 | 4 |
|---|---|---|---|
| | Day - barriers some of the time, or for some windows e.g. on quiet side | 4 | |
| | Night - reasons to keep all windows closed | 8 | 4 |
| | Night - bedroom windows OK to open, but other windows are likely to stay closed | 4 | |

| **#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 | 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 | 0 |

**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 | 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 | 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 | 0 |
| | > 2.8m | 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 | 0 |
|---|---|---|---|
| | >50% | 7 | |
| | >35% | 4 | |

| **#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 | 1 |
|---|---|---|---|
| | Dual aspect | 0 | |

| **#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 | 0 |
|---|---|---|---|---|
| | >65% | 6 | 3 | |
| | >50% | 4 | 2 | |
| | >35% | 2 | 1 | |

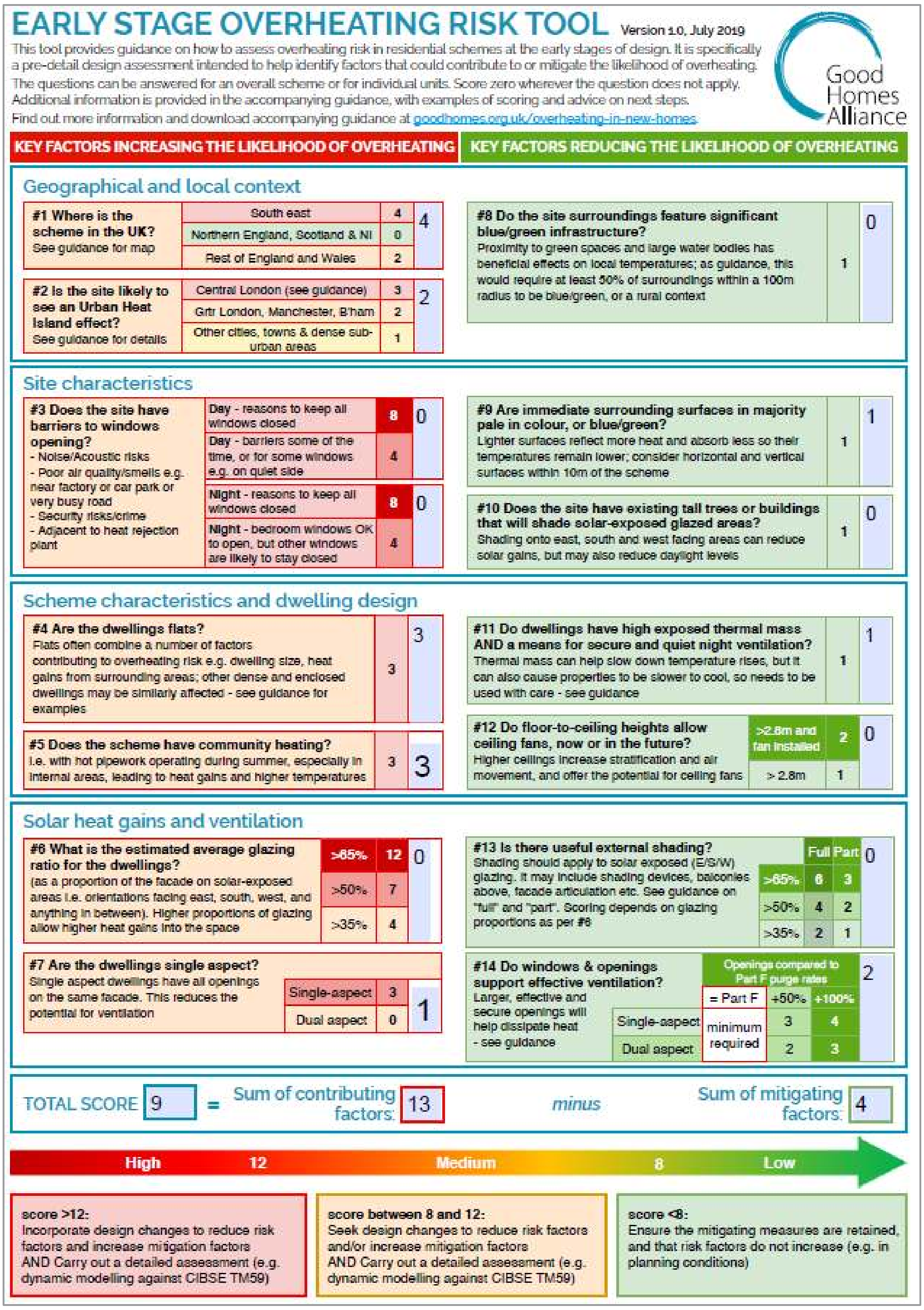
| **#14 Do windows & openings support effective ventilation?** Larger, effective and secure openings will help dissipate heat - see guidance | | Openings compared to Part F purge rates | | | 2 |
|---|---|---|---|---|---|
| | | = Part F | +50% | +100% | |
| | Single-aspect | minimum required | 3 | 4 | |
| | Dual aspect | | 2 | 3 | |

TOTAL SCORE 17 = Sum of contributing factors: 21 *minus* Sum of mitigating factors: 4

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) |
|---|---|---|

Figure T4.1. GHA overheating scoresheet for Phase 1 – Block C with noise constraints.



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Good Homes Alliance

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?**<br>See guidance for map | South east | 4 | 4 |
| | Northern England, Scotland & NI | 0 | |
| | Rest of England and Wales | 2 | |
| **#2 Is the site likely to see an Urban Heat Island effect?**<br>See guidance for details | Central London (see guidance) | 3 | 2 |
| | Grtr London, Manchester, B'ham | 2 | |
| | Other cities, towns & dense sub-urban areas | 1 | |

| | | |
|---|---|---|
| **#8 Do the site surroundings feature significant blue/green infrastructure?**<br>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 | 0 |

Site characteristics

| | | | |
|---|---|---|---|
| **#3 Does the site have barriers to windows opening?**<br>- Noise/Acoustic risks<br>- Poor air quality/smells e.g. near factory or car park or very busy road<br>- Security risks/crime<br>- Adjacent to heat rejection plant | Day - reasons to keep all windows closed | 8 | 0 |
| | Day - barriers some of the time, or for some windows e.g. on quiet side | 4 | |
| | Night - reasons to keep all windows closed | 8 | 0 |
| | Night - bedroom windows OK to open, but other windows are likely to stay closed | 4 | |

| | | |
|---|---|---|
| **#9 Are immediate surrounding surfaces in majority pale in colour, or blue/green?**<br>Lighter surfaces reflect more heat and absorb less so their temperatures remain lower; consider horizontal and vertical surfaces within 10m of the scheme | 1 | 1 |
| **#10 Does the site have existing tall trees or buildings that will shade solar-exposed glazed areas?**<br>Shading onto east, south and west facing areas can reduce solar gains, but may also reduce daylight levels | 1 | 0 |

Scheme characteristics and dwelling design

| | | |
|---|---|---|
| **#4 Are the dwellings flats?**<br>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?**<br>i.e. with hot pipework operating during summer, especially in internal areas, leading to heat gains and higher temperatures | 3 | 3 |

| | | | |
|---|---|---|---|
| **#11 Do dwellings have high exposed thermal mass AND a means for secure and quiet night ventilation?**<br>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 | 1 |
| **#12 Do floor-to-ceiling heights allow ceiling fans, now or in the future?**<br>Higher ceilings increase stratification and air movement, and offer the potential for ceiling fans | >2.8m and fan installed | 2 | 0 |
| | > 2.8m | 1 | |

Solar heat gains and ventilation

| | | | |
|---|---|---|---|
| **#6 What is the estimated average glazing ratio for the dwellings?**<br>(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 | 0 |
| | >50% | 7 | |
| | >35% | 4 | |
| **#7 Are the dwellings single aspect?**<br>Single aspect dwellings have all openings on the same facade. This reduces the potential for ventilation | Single-aspect | 3 | 1 |
| | Dual aspect | 0 | |

| | | Full | Part | |
|---|---|---|---|---|
| **#13 Is there useful external shading?**<br>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 | >65% | 6 | 3 | 0 |
| | >50% | 4 | 2 | |
| | >35% | 2 | 1 | |

| | | Openings compared to Part F purge rates | | | |
|---|---|---|---|---|---|
| | | = Part F | +50% | +100% | |
| **#14 Do windows & openings support effective ventilation?**<br>Larger, effective and secure openings will help dissipate heat - see guidance | Single-aspect | minimum required | 3 | 4 | 2 |
| | Dual aspect | | 2 | 3 | |

TOTAL SCORE 9 = Sum of contributing factors: 13 *minus* Sum of mitigating factors: 4

**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)

Figure T4.2. GHA overheating scoresheet for Phase 1 – Blocks B & E without noise constraints.

# APPENDIX T5

## Blinds mark-up

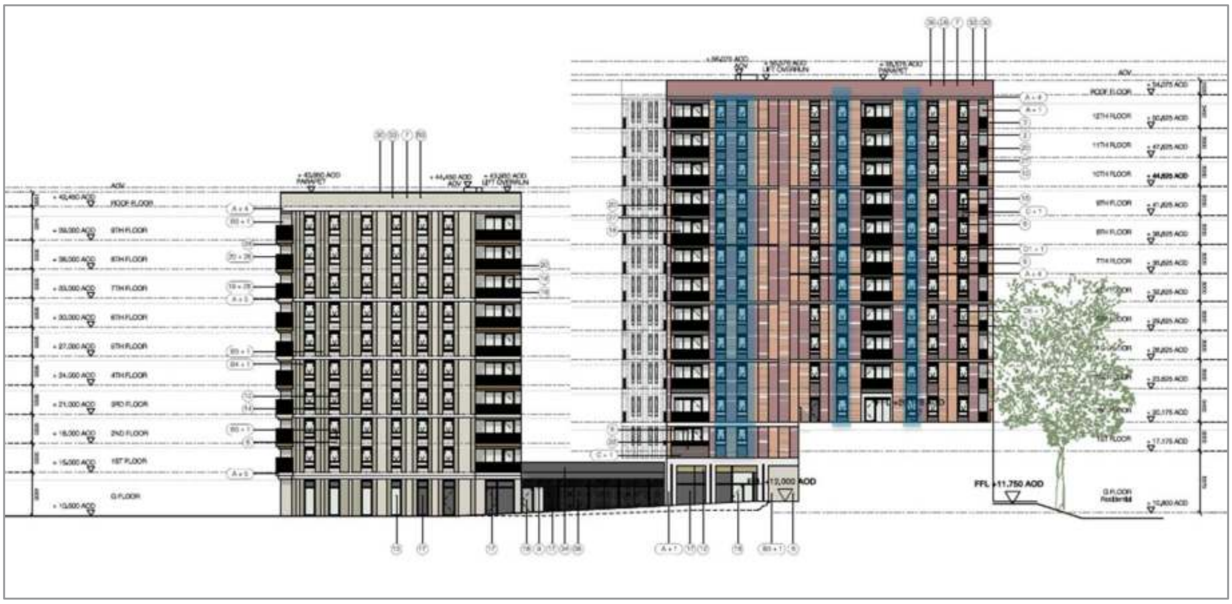

Figure T5.1. Block C1, east elevation. Windows that require blinds are marked up in blue (Patel Taylor drawings 23.10.2020).

Figure T5.2. Block C1, west elevation. Windows that require blinds are marked up in blue (Patel Taylor drawings 23.10.2020).

Figure T5.3. Block C2, east elevation. Windows that require blinds are marked up in blue (Patel Taylor drawings 23.10.2020).

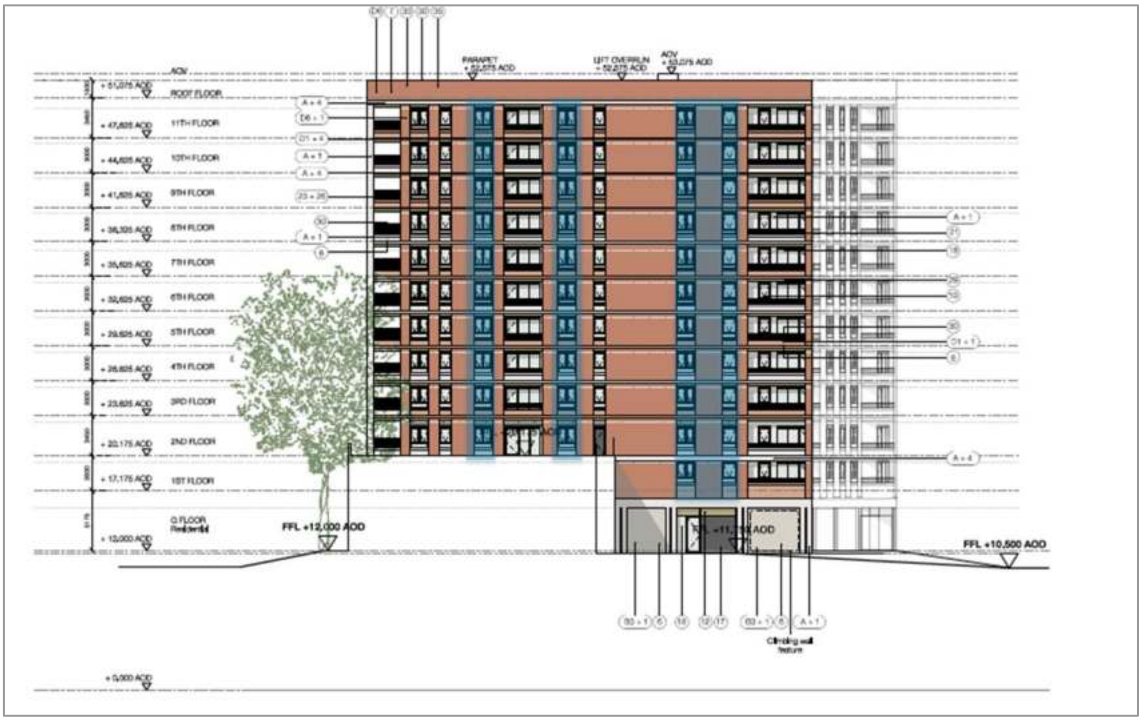

Figure T5.4. Block C2, west elevation. Windows that require blinds are marked up in blue (Patel Taylor drawings 23.10.2020).

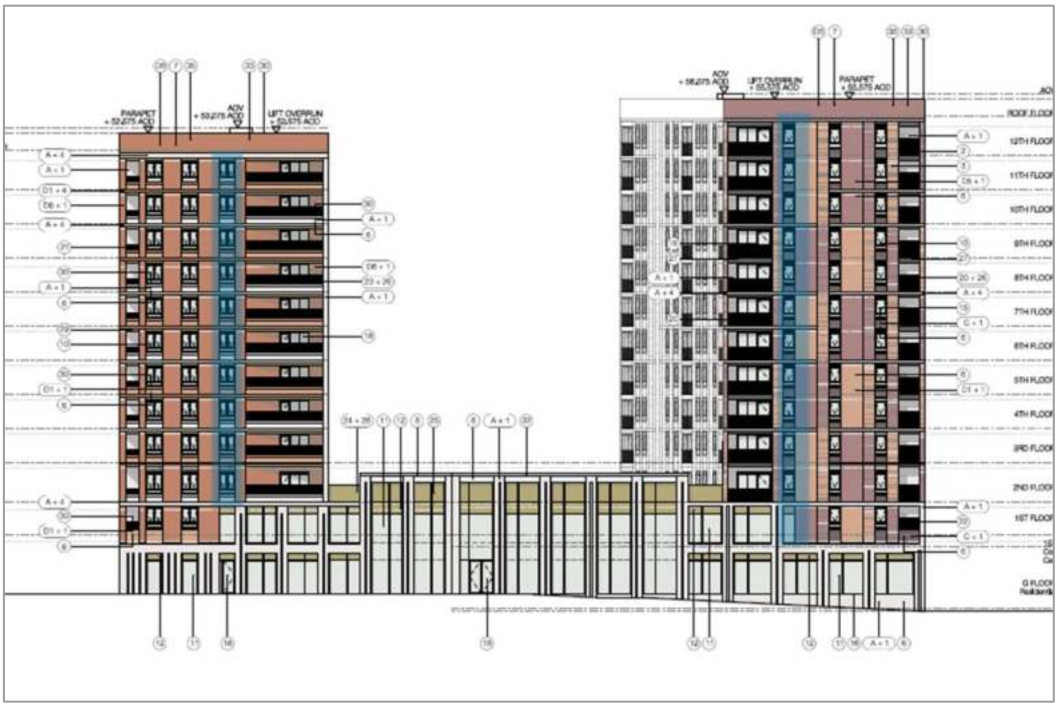

Figure T5.5. Blocks C1 & C2, west elevation. Windows that require blinds are marked up in blue (Patel Taylor drawings 23.10.2020).

# APPENDIX T6

## Results of DSY1 without blinds

Table below shows the results of the overheating assessment for the selected dwellings on the sensitive noise facades in Block C without the use of internal blinds.

**Table T6.1: Dwellings TM59 overheating results for DSY1 2020s without blinds**

| Unit | Room | TM59 Criterion A: Hours of exceedance (pass<3%) | TM59 Criterion B: Bedroom temperature hours >26°C (pass<32) | Overall compliance with TM59 |
|---|---|---|---|---|
| | | % Hours of overheating | Hours of overheating | |
| C1.1.5 2B3P | Bedroom 1 Single | 0.12 | 35.33 | Fail |
| | Bedroom 2 | 0.34 | 36.17 | Fail |
| | Living/Kitchen/Dining | 0.36 | N/A | Pass |
| C2.11.6 3B5P | Bedroom 1 | 0.00 | 15.17 | Pass |
| | Bedroom 2 | 0.00 | 33.83 | Fail |
| | Bedroom 3 Single | 0.00 | 33.67 | Fail |
| | Living/Kitchen/Dining | 0.10 | N/A | Pass |

# Appendix F Whole Life Cycle Carbon Assessment

**Whole Life Cycle Carbon Emissions Assessment**

Cambridge Road (RBK) LLP

# Cambridge Road Estate

Final

**Zeta Watkins**
BSc (Hons), MSc, CEnv, MIEMA

October 2020

# DOCUMENT CONTROL RECORD

## REPORT STATUS: FINAL

| Version | Date | Reason for issue | Author | Checked by | Approved for Issue by Project Manager |
|---|---|---|---|---|---|
| v.1 | 02.10.2020 | Draft | ZW | KP | ND |
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| | | | | | |

## ABOUT HODKINSON CONSULTANCY

Our team of technical specialists offer advanced levels of expertise and experience to our clients. We have a wide experience of the construction and development industry and tailor teams to suit each individual project.

We are able to advise at all stages of projects from planning applications to handover.

Our emphasis is to provide innovative and cost-effective solutions that respond to increasing demands for quality and construction efficiency.

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# Executive Summary

The purpose of this Whole Life Cycle Carbon Emissions (WLCCE) assessment is to demonstrate that the proposed Cambridge Road Estate development by Cambridge Road (RBK) LLP in the Royal Borough of Kingston upon Thames, has taken actions to reduce embodied carbon where possible. This is an initial assessment based on the best available information to date.

The hybrid planning application comprises Plots B, C and E (Detailed) and Plots A, D, F-H, J-N and Q (Outline) – both are included in this assessment.

Whole Life-Cycle Carbon (WLC) emissions are the carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal. They capture a building's operational carbon emissions from both regulated and unregulated energy use, as well as its embodied carbon emissions, i.e. those associated with raw material extraction, manufacture and transport of building materials, construction and the emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal. It provides a picture of a building's carbon impact on the environment

At this stage of the design a baseline energy model of embodied carbon has been created using generic data and estimates the total carbon emissions to be **319 kg $CO_2$e/ $m^2$ GIA** over 60 years, this however does not account for the operational energy and water use, as per GLA requirements. When these are included the total emissions are **664 kg$CO_2$/$m^2$ GIA over 60 years.**

The proposed development is exceeding both the WLC Benchmark set by the GLA and the Aspirational Benchmark, thus demonstrating a sustainable design.

A set of high-level observations are set out in the report which could be considered at detailed design stage. As the GLA guidance is not yet adopted, or the associated methodology consulted upon, these serve to inform the design team on best practice in the design.

# CONTENTS

# 1. INTRODUCTION

1.1 This Whole Life Cycle Carbon Emissions (WLCCE) Assessment has been prepared by Hodkinson Consultancy, a specialist energy and environmental consultancy for planning and development, appointed by Cambridge Road (RBK) LLP.

1.2 The purpose of a WLLCE assessment is to demonstrate that the proposed development at Cambridge Road Estate in the Royal Borough of Kingston upon Thames, has taken actions to reduce embodied carbon where possible. This is an initial assessment based on the best available information to date.

1.3 This assessment will aim to help the design team understand, at concept design stage, the lifetime consequences of their design decisions.

# 2. POLICY AND REGULATIONS

## Intend to Publish London Plan (2019)

2.1 The Panel of Inspectors report into the draft London Plan was published in October 2019. The Mayor considered the Inspectors' recommendations and, in December 2019, issued to the Secretary of State the Intend to Publish London Plan. The Secretary of State responded to this in March 2020 and the Mayor is now considering the Secretary of State's response and taking the steps to finalise the plan.

2.2 The following policies are proposed in the Intend to Publish London Plan are considered relevant to the proposed development and this Statement:

2.3 **Policy SI 2 Minimising Greenhouse Gas Emissions, states:**

*'Development proposals referable to the Mayor should calculate whole life-cycle carbon emissions through a nationally recognised Whole Life-Cycle Carbon Assessment and demonstrate actions taken to reduce life-cycle carbon emissions:*

*Operational carbon emissions will make up a declining proportion of a development's whole life-cycle carbon emissions as operational carbon targets become more stringent. To fully capture a development's carbon impact, a whole life-cycle approach is needed to capture its unregulated emissions (i.e. those associated with cooking and small appliances), its embodied emissions (i.e. those associated with raw material extraction, manufacture and transport of building materials and construction) and emissions associated with maintenance, repair and replacement as well as* *dismantling, demolition and eventual material disposal). Whole life-cycle carbon emission assessments are therefore required for development proposals referable to the Mayor. Major non-referable development should calculate unregulated emissions and are encouraged to undertake whole life-cycle carbon assessments. The approach to whole life-cycle carbon emissions assessments, including when they should take place, what they should contain and how information should be reported, will be set out in guidance'.*

2.4 The above policy explains that referable schemes, submitted following adoption of the new London Plan will be required to carry out a WLCCE assessment. The methodology for demonstrating compliance is out in draft and will be consulted upon on following publication of the new London Plan. The draft highlights that project could be required to report at pre-application, planning and post-completion stages.

2.5 This assessment would form a part of the concept design and inform the design and material choices through the course of the project rather than appear as an afterthought later in the design.

## Local Policy: Royal Borough of Kingston Upon Thames

2.6 The Royal Borough of Kingston Upon Thames' Core Strategy document was adopted in April 2012. The following policies are considered relevant to this Statement:

2.7 **Policy CS1 – Climate Change Mitigation**: All development must be designed and built to make the most efficient use of resources, reduce its lifecycle impact on the environment and contribute to climate change mitigation and adaptation by:

> Reducing $CO_2$ emissions during construction and throughout the lifetime of the development;

> Building to the highest sustainable design and construction standards;

> Minimising water consumption;

> Using sustainable materials;

> Reducing levels of pollution, air, water noise and light; and

> Planning for increased flood risk.

2.8 **Policy DM1 – Sustainable Design and Construction Standards**: The Council will require all new residential developments to achieve successively higher levels of the Code for Sustainable Homes Level category for energy/$CO_2$. New development should minimise air, noise and contaminated land impacts in line with industry best practice. Development proposals for contaminated land should include remediation measures. The Council will promote good carbon management by monitoring $CO_2$ emissions to ensure the development is operated within the $CO_2$ emissions standards of the as-built specification and those outlined within the Council's Sustainable Design and Construction SPD. Measures to ensure these standards are maintained will be monitored by the Council.

2.9 Where appropriate, other new build developments over 500 $m^2$ are encouraged to achieve higher levels of the appropriate BREEAM standard.

2.10 Since the publication of the Royal Borough of Kingston Upon Thames' Core Strategy Document in April 2012, the Code for Sustainable Homes was formally wound down following a technical housing standard review. This was announced by the Ministerial Statement by Rt. Honourable Eric Pickles on 25th March 2015 and the Government withdrew the Code for Sustainable Homes on 22nd April 2015.

## Guidance Documents

2.11 Preliminary guidance has been released by the Greater London *Authority "Whole Life-Cycle Carbon Assessments guidance – April 2020".* It outlines how to prepare a WLCCE assessment which should accompany all referable planning applications in line with London Plan Policy SI 2. This document is currently out for consultation but has been used and referenced throughout this assessment.

2.12 In addition, the following guidance is available to conduct assessments:

> **BS EN 15978:2011 -** *Sustainability of construction works. Assessment of environmental performance of buildings. Calculation method.*

> **ISO 14040:2006 -** *Environmental management — Life cycle assessment — Principles and framework.*

> **RICS Professional Statement Whole life carbon assessment: 2017 -** *Whole life carbon assessment for the built environment.*

# 3. DEVELOPMENT OVERVIEW

## Site Location

3.1 The proposed development site at Cambridge Road Estate in the Royal Borough of Kingston upon Thames is approximately 9 hectares and is located to the immediate south of the A2043 Cambridge Road and Hawks Road, as shown in Figure 1 below.

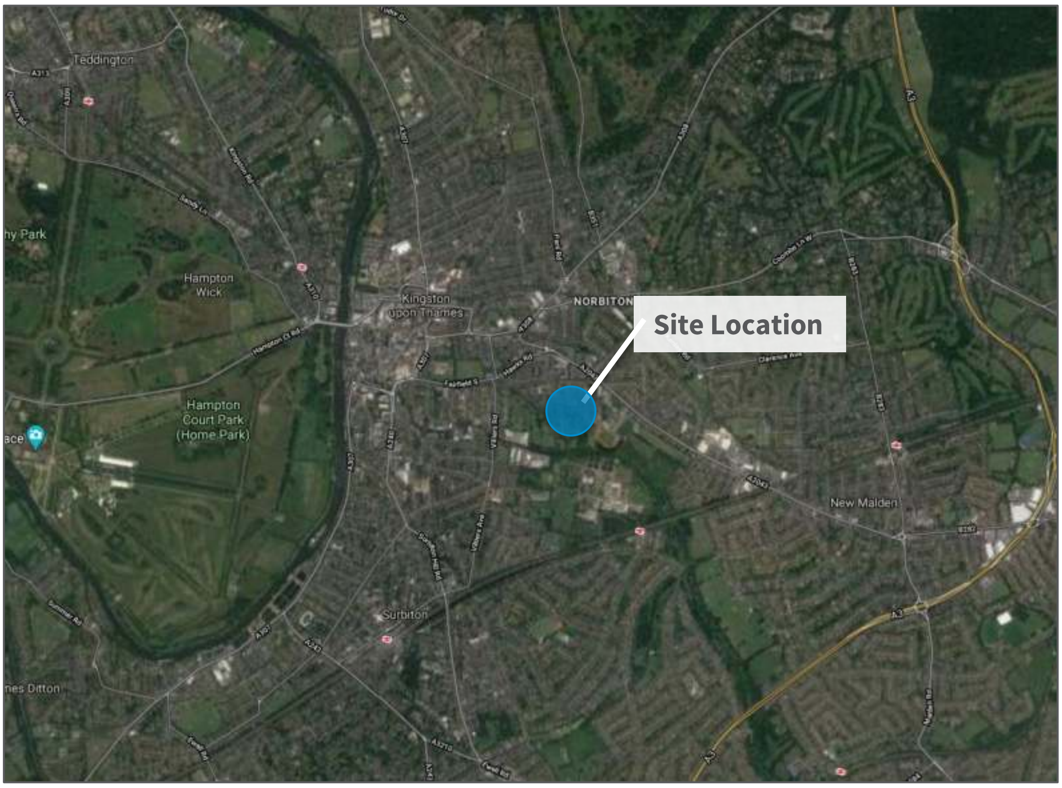


Figure 1: Site Location – Map data © 2020 Google

3.2 The land use in the immediate vicinity of the site is predominantly residential and of a domestic suburban character and scale. Cambridge Road Estates was built in the late 1960s and early 1970s and currently comprises 832 residential homes; Hawks Road Clinic within the northwest of the site; The Bull and Bush Hotel within the west of the site; and Piper Community Hall within the south of the site. The site also includes small formal and informal play spaces and ground level car parking areas.

## Proposed Development

3.3 The proposed development is described as follows:

*"Hybrid Outline Planning Application for a mixed use development, including demolition of existing buildings and erection of up to 2,170 residential units (Use Class C3), 290sqm of flexible office floorspace (Use Class E), 1,395sqm of flexible retail/commercial floorspace (Use Class E/Sui Generis), 1,250sqm community floorspace (Use Class F2), new publicly accessible open space and associated access, servicing, landscaping and works.*

*Detailed permission is sought for access, layout, scale, appearance and landscaping of Phase 1 for erection of 452 residential units (Use Class C3), 1,250sqm community floorspace (Use Class F2), 290sqm of flexible office floorspace (Use Class E), 395sqm of flexible retail/commercial floorspace (Use Class*

*E/Sui Generis), new publicly accessible open space and associated access, servicing, parking, landscaping works including tree removal, refuse/recycling and bicycle storage, energy centre and works ("the Proposed Development")."*

3.4 Figure 2 below illustrates the proposed masterplan layout.

**Figure 2: Proposed Masterplan Layout – Patel Taylor (October 2020)**

## BREEAM

3.5 BREEAM New Construction 2018 is being used to assess the commercial units. This is an assessment method to ensure best environmental practice is incorporated in the planning, design, construction and operation of commercial buildings and the wider built environment.

3.6 There are specific credits within BREEAM that aim to reduce the burden on the environment from construction products by recognising and encouraging measures to optimise construction product consumption efficiency and the selection of products with a low environmental impact (including embodied carbon), over the life cycle of the building.

3.7 It is anticipated that the BREEAM assessment for the shell only commercial units will seek to achieve these credits.

# 4. WHOLE LIFE CYCLE CARBON EMISSIONS ASSESSMENT

4.1 Undertaking WLCCE assessments is a way to fully understand and minimise the carbon emissions associated with building designs over the entire life cycle of the building. This will be done at the proposed development in order to quantify the carbon dioxide emissions that will be released from the proposed development, considering not only operational and embodied emissions but also demolition, construction, and refurbishment/replacement cycles.

4.2 The new draft London Plan has proposed a requirement for all new referable developments to calculate and reduce WLCCE, this is both embodied and operational carbon:

> **Operational carbon** is the energy required to heat and power a building during use;

> **Embodied carbon** is the carbon that is released in the manufacturing, production, and transportation and construction of the building materials used.

4.3 In addition to the two metrics above there are additional life cycle stages that are considered during WLLCE assessments, these include demolition, end of life and refurbishment/replacement cycles.

4.4 The two metrics (operation and embodied) and the additional life cycle stages, as noted above, have been included in this but additional information will be required as the design progresses to ensure the assessment can give valuable results.

4.5 Undertaking a WLCCE assessment provides a full overview of the material and building environmental impacts of a building using science-based metrics (e.g. Global Warming Potential). It also identifies the overall best combined opportunities for reducing lifetime emissions, and also helps to avoid any unintended consequences of focusing on operational emissions alone.

4.6 A low carbon building is one that optimises the use of resources both to build it and to use it over its lifetime. The assessment will help the design team understand, at design stage, the lifetime consequences of their design decisions. This promotes durability, resource efficiency, reuse, and future adaptability, all of which contribute to life-time carbon reductions.

# 5. METHODOLOGY

5.1 This is an initial assessment based on the best available information which will need to be updated as the project progresses. WLCCE assessments are sensitive to changes in design and specification and therefore detailed design will impact the results as the schemes progress.

5.2 As detailed information is not yet available a baseline figure has been determined through the use of a carbon designer tool available on One Click. The Carbon Designer tool allows very quick baseline building creation with minimal knowledge about the project and allows optioneering choices and their impacts easily. Based on this we can provided some high-level observations that could reduce the embodied emissions.

5.3 As the design progresses into the detail stages, the embodied emissions associated with the development can be developed and refined with bespoke recommendations made. In the interim, the estimated emissions associated with the operational energy of the development are reported, with metric of potential methods to alter these during detail design.

## Operational Carbon

5.4 Operational energy is the inputted energy required for all heating and power needs. It can be split into two variants:

> **Regulated Emissions** - which are assessed using the Government's approved methodology for Building Regulations Part L compliance, the Standard Assessment Procedure (SAP); and

> **Unregulated Emissions** – energy use as a direct result of user behaviour. This includes cooking, white goods (fridges, washing machines etc), and plug in electrical loads (televisions, laptops, lamps etc).

5.5 Both of the above elements will be accounted for in this WLCCE assessment. For clarity, as unregulated energy demands are largely reliant on the behaviour of occupants, they have been considered a fixed entity in the calculations.

### Residential

5.6 The estimated energy demand for the residential portion of the development has been calculated using the Standard Assessment Procedure 2012 methodology. SAP calculates the Regulated energy demand for residential dwellings.

5.7 SAP calculations have been carried out for representative dwelling types (for the detailed component of the development). These encompass ground, mid, and top floor flats and represent a fair aggregation of the expected unit mix of the development.

5.8 In order to calculate the energy demands across the entire scheme, the current accommodation schedule has been used to extrapolate the results from the modelled units. This has been done for both the detailed and outline parts of the application.

5.9 The Unregulated energy demands for the residential units have been calculated using the methodology outlined in the SAP 2012 document. This calculates the $CO_2$ emissions associated with appliances and cooking.

### Non-Residential

5.10 The estimated energy demand for the non-residential elements of the development has been calculated using Simplified Building Energy Model (SBEM) software, using the National Calculation Method (NCM 2013 Edition). SBEM calculates the Regulated energy demands associated with hot water, space heating and fixed electrical items, as well as Unregulated energy demands.

5.11 Sample SBEM calculations have been carried out on example units of the expected use types for the Proposed Development. For the outline scheme, these are not fixed, but sample calculations have been extrapolated in order to gain energy demand estimates for the whole scheme. At present, these have not been included in the WLLCE assessment. The completion of the SBEM modelling is not likely to increase the operational carbon of the development as they are being constructed to a shell only specification.

## Embodied Carbon

5.12 Embodied carbon is the sum of Green House Gas (GHG) emissions resulting from the mining, harvesting, processing, manufacturing, transportation, and installation of building materials.

### One Click LCA

5.13 OneClick LCA is the software that has been used to conduct the WLCCE assessment. This is a web based approved tool for WLCCE assessments and design software for buildings and infrastructure. It consists of a large database of generic and average Life Cycle Indicator (LCI) data, and global Environmental Product Declaration (EPDs). The most suitable option for each material (where available) was chosen from the database in OneClick. The material LCI data has been chosen to be representative of the typical UK supply chain.

5.14 The OneClick LCA default values for distances travelled to site for the construction materials were used for each material item. More specific values will be used when the assessment is re-run once the design of the development has progressed further.

5.15 The following life cycle stages are included within the assessment as standard:

- **A1 - A3 –** This includes all construction materials;
- **A4 –** This includes all transportation to site;
- **A5 –** This includes all construction site impacts;
- **B3 – B5 –** This includes the repair, refurbishment, and replacement of building elements;
- **B6 - B7 –** This includes use the energy, and water;
- **C1 - C4 –** This includes the end of life scenarios for building elements.

5.16 As noted above, the One Click Carbon Designer tool has been used to determine the baseline embodied emissions as a building model is not yet available. As the design develops, we will update and refine the tool to reflect the quantity and types of materials being used.

## Construction Impacts

5.17 In addition to embodied carbon in the materials used for construction, GHG emissions will be created by transportation of materials to site and operation of onsite plant and machinery. These emissions are typically materially smaller than embedded GHG emissions. Guidance from the Building Research Establishment (BRE) indicates 1,400 kg of $CO_2$e per £100,000 of project value.

5.18 The project value has been provided by the Applicant, which would result in construction transport GHG emissions of **8,265 tonnes of $CO_2$e.**

## Study Period

5.19 The reference study period (RSP) for domestic projects is 60 years, this is based on the principles outlined in BS EN 15978: 2011, section 7.3 and the RICS guidance.

5.20 RSPs are fixed to enable comparability between whole life carbon results for different projects. It ensures that the assessment is representative of typical service life of different building elements.

## Data Sources

5.21 The assessment has utilised multiple data sources described above and is based on the level of detail available at the current stage of design. The following data sources have been used to complete the WLCCE assessment:

**Table 1: Data Sources**

| Data | Data source |
|---|---|
| **Operational energy** | SAP and SBEM Energy calculations – Hodkinson Consultancy |
| **Construction site impacts** | Project value provided by applicant and baseline target provided by BRE |
| **Material types and volumes** | Information provided by Patel Taylor on 22nd September 2020 |
| **Transport data** | RICS guidance |
| **Building areas** | 212,199m$^2$ taken from accommodation schedules |

# 6. GENERAL OBSERVATIONS

## Green Infrastructure

**6.1** It is known that green roofs will be installed, these are considered effective in the reduction of $CO_2$ (when greater than 1000 m$^2$ in size) because of their ability to reduce energy consumption of buildings and sequester carbon in plants and substrate.

**6.2** The installation of green roofs typically contains less embodied energy than that of traditional roof systems. Typical roof systems have an expected lifespan of 30 years (RICS Guidance), the implementation of a green roof extends the roof's lifetime beyond this.

**6.3** The landscaping strategy is currently proposed to be a mix of both soft and hard landscaping as demonstrated in Figure 3. In order to reduce the embodied carbon of the hard landscaping any demolished concrete should be crushed on-site and potentially used a subbase to reduce the overall embodied carbon of the landscaping.

Figure 3: Hard and soft landscaping (Patel Taylor, 2020)

6.4 Plants and trees capture and store carbon dioxide emissions from the atmosphere, this is known as sequestering carbon dioxide emissions. The development proposal increases the available flora and fauna through a net increase trees and provision of green and brown roofs. Trees have been included within the One Click Assessment under the 'carbon sequestration' section.

6.5 Based on research papers by the Natural Environment Research Council Centre for Ecology and Hydrology (formerly Institute of Terrestrial Ecology) and referenced papers by The Royal Institution of Chartered Surveyors (RICS). The trees and green and brown roof proposed will sequester an additional ~26,000 kg$CO_2$.

## Building Materials

6.6 The construction of the proposed development is likely to be reinforced concrete framed buildings. The efficient stacking of floor plates will allow for efficiency in design and mitigate the risk of over engineering and excessive material use.

## Building Heights and Form

6.7 Apartment blocks up to 13 storeys high are proposed at Cambridge Road Estate. High-rise buildings, like those in this proposed development, gain efficiency in the ratio of envelope to gross floor area because while each floor will typically have a similar amount of façade, the environmental impact of the roof and ground floor is divided by the number of floors – the more floors the better in this respect.

6.8 The avoidance of overly complex building forms and junction designs across the site offers a more consistent and reliable standard of construction which will assist in air tightness and reducing the impact of heat loss through thermal bridges.

6.9 It is proposed that the developer will engage Countryside Properties as its Construction Manager. They have a track record of limiting and diverting waste to landfill. In 2018 they diverted 99.4% of the waste. This means materials are used efficiently. Where possible and safe to do so, recycled materials are used. These actions reduce the embodied energy of the development.

6.10 The Cambridge Road Estate will total around 2,170 new dwellings which is an increase over the existing number of dwellings on the development. This improves the efficiency of how the land is used. Efficient land use along with the developer's record on waste diversion will help to reduce the embodied energy associated with the development further.

## Zero Carbon

6.11 As of 1st October 2016, London Plan Policy requires that all major residential developments are subject to an additional offset payment to meet a 100% reduction in Regulated $CO_2$ emissions to achieve the standard of Zero Carbon. This payment is made to the local borough's Carbon Offsetting Fund and is expected to be allocated to carbon reduction savings elsewhere in the borough.

6.12 As set out in the Energy Statement provided by Hodkinson Consultancy the site is meeting the Greater London Authority's (GLA) definition of Net Zero Carbon. Based on this, the operational emissions can be set as zero for the first thirty years when finalising the assessment once the design is more progressed.

# 7. WHOLE LIFE CYCLE CARBON RESULTS

## Benchmark Comparison

7.1 The results when compared to the GLA benchmark values are shown in Table 2 below:

**Table 2: Whole Life Carbon Baseline (GLA Guidance)**

| | Project kg $CO_2/m^2$ GIA | WLC Benchmark kg $CO_2e/m^2$ GIA | Aspirational Benchmark kg $CO_2e/m^2$ GIA |
|---|---|---|---|
| Modules A1 – A5 | 264 | 750 to 850 | 450 to 500 |
| Modules B – C (excluding B6 and B7) | 55 | 300 to 400 | 180 to 240 |

7.2 It must be noted that no benchmark has been set by the GLA for operational and energy use (life cycle stages B6-B7) due to insufficient data at present. The results for these have therefore been omitted from the totals above. The total is therefore **319kgCO$_2$/m$^2$ GIA over 60 years.**

7.3 When these emissions are included in the calculation the total emissions are expected to be **664 kgCO$_2$/m$^2$ GIA over 60 years.**

7.4 It is important to note that baseline data (via the Carbon Designer) has been used for building elements and no services or external areas have been included in this iteration of the WLLCE assessment and therefore the comparison to the baseline above is not yet conclusive.

7.5 The proposed development is exceeding both the WLC Benchmark set by the GLA and the Aspirational Benchmark, thus demonstrating a sustainable design.

## Results

7.6 Once all of the data (including the baseline data for embodied energy) was inputted into One Click LCA, the results for both the outline and detailed applications are as follows:

**Table 3: One Click LCA Results**

| Category | Global warming potential | Total kgCO$_2$e over 60 years |
|---|---|---|
| **A1-A3** | Construction Materials | 52,770,194 |
| **A4** | Transport | 1,686,700 |
| **A5** | Site operations | 1,563,381 |
| **B3** | Repair | 0 |
| **B4** | Replacement | 7,815,140 |
| **B6–B7** | Operational energy and water use | 74,334,057 |
| **C1-C4** | Re-use, recycling, or disposal | 3,796,906 |
| | **Total** | **140,966,378** |

7.7 Preliminary SAP and SBEM modelling have allowed us to provide a good estimate of the predicted operational emissions associated with the proposed development.

7.8 As demonstrated in Figure 4 below, categories B6 and B7 (operational energy and operational water use) are the highest contributors to the overall emissions.

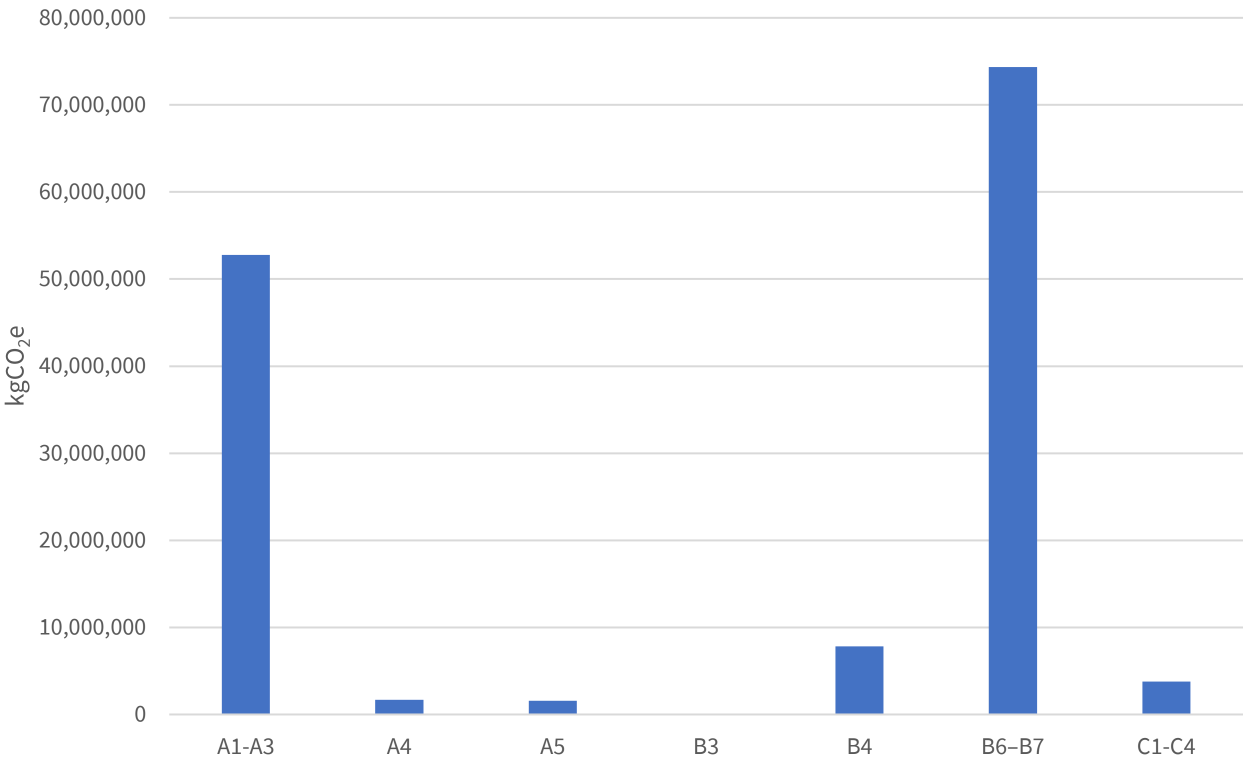


**Figure 4: Total kgCO$_2$e - Life Cycle Stages**

7.9 The operational energy and water use (B6 and B7) make up 52% of the overall emissions for the proposed development whilst materials (A1 – A3) make up 37.5% of the overall emissions.

7.10 Of the materials used in the proposed development concrete is expected to emit the most kgCO$_2$e, followed by metals. A more detailed breakdown is provided in Figure 5 below.

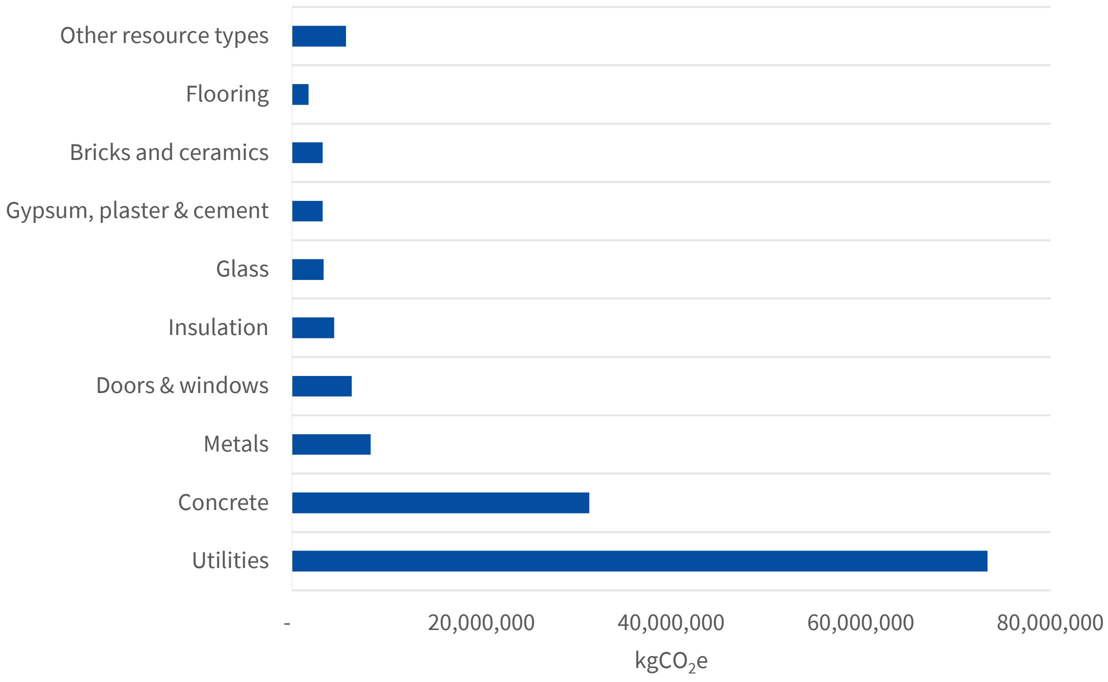


**Figure 5: Total kgCO2e – Resource Types**

# 8. HIGH LEVEL OBSERVATIONS

8.1 A set of high-level observations are set out below that could be considered as a part of the detail design post planning.

8.2 These are presented from the perspective of embodied carbon and life cycle only and must be considered alongside other design considerations by other members of the design team.

> To maximise the opportunities arising from the potential demolition of the existing site, **a pre-demolition audit** could be undertaken as part of the Construction Method Statement. This would identify and quantify the materials to encourage and maximise reuse and recycling.; for example, all demolished concrete can be crushed on-site and used onsite as hard core, fill, or in landscaping.

> The **future demolition and deconstruction** of the development could be considered at the design stage. Consideration to be given to ways to facilitate dismantling, such as keeping the use of welding to a minimum (although it is acknowledged this may not always be possible);

- Similarly, a **maintenance and repair schedule** could also be produced during the design life of the development to ensure that materials and pieces of equipment are able to remain in situ during their expected lifespan. This will minimise the need to replace and refurbish and reduce emissions under life cycle stages C1-C4.

- **Using concrete as a finish** can reduce the need for other finishing materials. In addition, exposed areas of concrete can optimise the thermal mass performance. Thermal mass, with adequate ventilation, can be used to control daytime peak temperatures of a space and therefore reduce or minimise the need for air-conditioning. The areas where this can be done would need to be carefully considered. The durability of concrete also offers further potential savings through a reduction in the need for maintenance and repair (compared to a painted finish for example).

- The transportation of materials from the manufacturing facility to the building site adds to the carbon of the development. **Buying from local sources** or **utilising off-site manufacturing processes** could help reduce the emissions produced during transportation. There is a balance to be struck between material transport and processes deployed in their manufacture. As such details on this cannot be known until the detailed design phase. This review would have impacts under life cycle A4, emissions from transportation to site.

- **Innovative cement mixes** are now increasingly available, using a mixture that is 95% ground granulated furnace slag (GGBS) and 5% as the activator can save up to 90% in emissions. This cement mixture could be investigated further for use at the appropriate stage, and if suitable could be used for building elements such as piles, floors, walls, and reinforced foundations. If implemented this could facilitate the reduction of life cycle stages A1-A3 (materials) quite significantly.

- The façade is under constant wear from the environment which can lead to frequent repairs and maintenance. By using **durable materials**, this not only reduces the cost and frequency of refurbishment but also reduces the use of material replacement and its associated carbon footprint.

# 9. CONCLUSION

9.1 The purpose of this Whole Life Cycle Carbon Emissions (WLCCE) assessment is to demonstrate that the proposed Cambridge Road Estate development by Cambridge Road (RBK) LLP in the Royal Borough of Kingston upon Thames, has taken actions to reduce embodied carbon where possible. This is an initial assessment based on the best available information to date.

9.2 The hybrid planning application comprises Plots B, C and E (Detailed) and Plots A, D, F-H, J-N and Q (Outline) – both are included in this assessment.

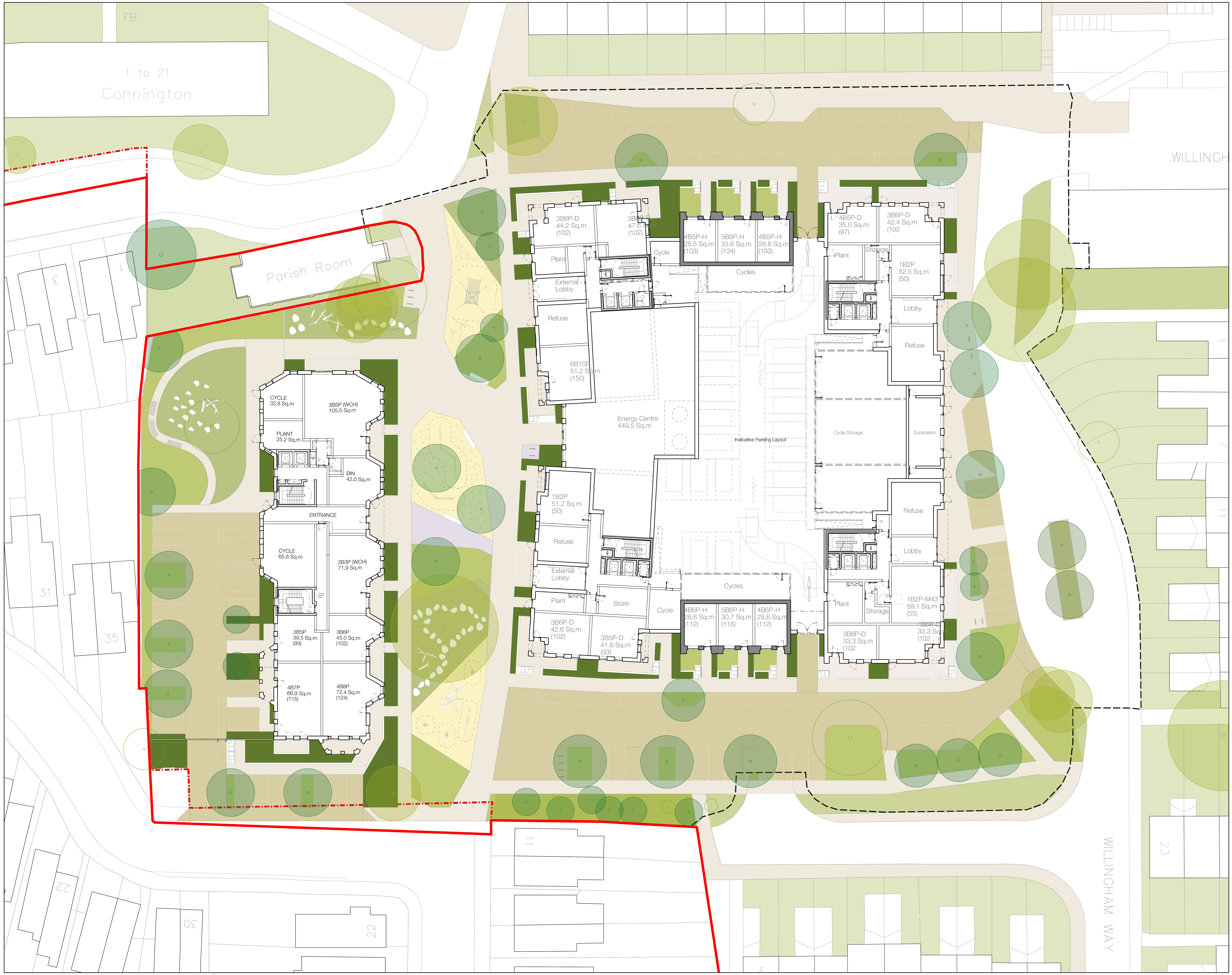
**9.3** Whole Life-Cycle Carbon (WLC) emissions are the carbon emissions resulting from the construction and the use of a building over its entire life, including its demolition and disposal. They capture a building's operational carbon emissions from both regulated and unregulated energy use, as well as its embodied carbon emissions, i.e. those associated with raw material extraction, manufacture and transport of building materials, construction and the emissions associated with maintenance, repair and replacement as well as dismantling, demolition and eventual material disposal. It provides a picture of a building's carbon impact on the environment

**9.4** At this stage of the design a baseline energy model of embodied carbon has been created using generic data and estimates the total carbon emissions to be 319 kg CO2e/ m2 GIA over 60 years, this however does not account for the operational energy and water use, as per GLA requirements. When these are included the total emissions are 664 kgCO2/m2 GIA over 60 years.

**9.5** The proposed development is exceeding both the WLC Benchmark set by the GLA and the Aspirational Benchmark, thus demonstrating a sustainable design.

**9.6** A set of high-level observations are set out in the report which could be considered at detailed design stage. As the GLA guidance is not yet adopted, or the associated methodology consulted upon, these serve to inform the design team on best practice in the design.

# Appendix G Indicative Energy Centre Layouts (GA / Section)

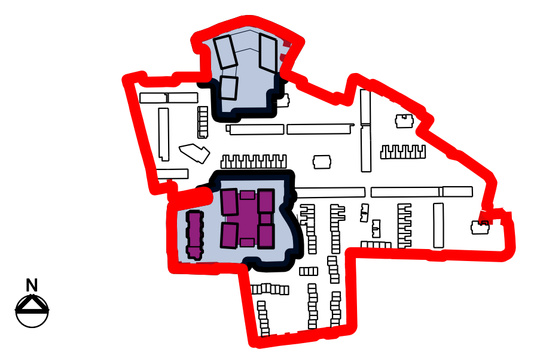


## General Notes

DO NOT SCALE. All dimensions must be checked on site, errors are to be reported.

**Contractors must ensure that cross referenced drawings and specifications noted on these drawings are checked on a regular basis to ensure that the latest revisions are used.**

## Key Plan



## Site Boundary

- Title boundary
- Planning boundary
- Detailed application boundary

## Landscape Key

- Planting type 1
- Amenity grass
- Paving type 1
- Paving type 2
- Tarmac roadway
- Compacted gravel play surface
- Existing trees retained
- Raised seating/ retaining wall
- Proposed trees

**Scale 1:250 @ A1**

0 2m 5m 10m 20

| Issue Record | | By | Chk | Date |
|---|---|---|---|---|
| P01 | For information | CW | NE | 23.10.2020 |

**Title**
Phase 01 masterplan
Buildings B and E
GA Landscape Plan

**Project**
Cambridge Road

**Scale**
1:250 @ A1 1:500 @ A3

**Status**
For Information

**Drawing Number** 503-PTA-PH1-00-DR-LA-4301
**Revision** P01

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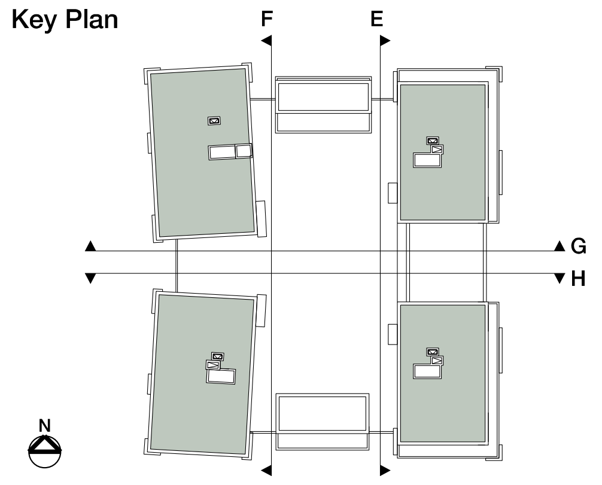
## 01 Section/Elevation G-G (south elevations of E1 & E5)

Scale 1:250

## 02 Section/Elevation H-H (north elevations of E6 and E4)

Scale 1:250

**Key Plan**



**General Notes**

DO NOT SCALE. All dimensions must be checked on site, errors are to be reported.

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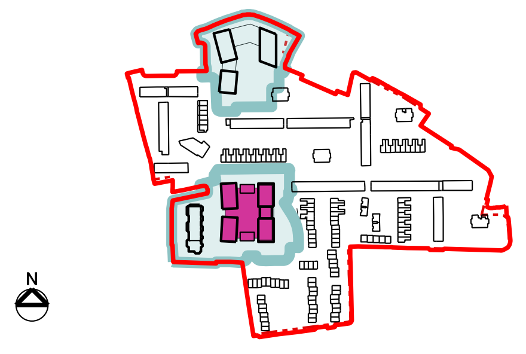
**Key Plan**



**Material key (Building E)**

A. Brick type A (White brick)
B. Brick type B (Buff)
B1. Brick type B1 (Buff 1)
B2. Brick type B2 (Buff 2)
B3. Brick type B3 (Buff 3)
B4. Brick type B4 (Buff 4)
C. Brick type C (Dark plinth)
D. Brick type D (Red brick)
D1. Brick type D1 (Red 1)
D2. Brick type D2 (Red 2)
D3. Brick type D3 (Red 3)
D4. Brick type D4 (Red 4)
D5. Brick type D5 (Red 5)

1. Stretcher bond brickwork
2. Soldier course brickwork
3. Stack bond brickwork
4. Bonded soldier course brickwork
5. Projecting stepped basketweave brickwork
6. Recessed brickwork
7. Rusticated brickwork
8. Projecting header brickwork pattern
9. Striped band brickwork

10. Precast string course
11. Precast entrance canopy and surround

12. PPC metal cladding system, mid bronze-coloured. Diamond pattern
13. PPC perforated mid bronze-coloured metal canopy system
14. PPC dark bronze-coloured metal surround to double height entrances,

15. PPC metal faced outward opening top-hung reversible window. Dark bronze-coloured. Single, double or triple paned windows as drawn.
16. Integrated ventilation panel with PPC metal perforated screen
17. Precast sill
18. Brick sill
19. Metal sill flashing

20. PPC metal perforated screen door
21. PPC metal faced dark bronze-coloured external door system
22. Timber faced external door system

23. PPC metal balcony balustrade. Metal flats. 40mm metal flats @ 100mm centres.
24. 675mm brick balustrade topped with metal pickets. 10mm square rods @ 100mm centres.
25. PPC perforated metal balustrade. Nom. 50% free area. Refer to DAS Volume 2 Chapter 6 for perforation pattern.
26. 1500mm high balcony balustrade (wind mitigation)

27. PPC metal, dark bronze-coloured fascia and soffit
28. PPC metal, mid bronze-coloured fascia and soffit
29. PPC metal, light bronze-coloured fascia and soffit

30. Rendered soffit to match brickwork colour

31. Brick on-edge coping
32. Metal coping
33. Precast coping
34. Brick parapet
35. Metal parapet
36. Bio-diverse roof with PV panels

37. Decorative PPC dark bronze-coloured metal entrance gates.
38. Free standing brick wall

**Scale 1:250 @ A1**

0 1 2 3 4 5m 10m 15m 20m

| Issue Record | | By | Chk | Date |
|---|---|---|---|---|
| P02 | For Information | LR | NE | 23.10.2020 |
| P01 | For Information | EP | NE | 13.10.2020 |

**Title**

Building E
Section Elevations G-G, H-H

**Project**

Cambridge Road

**Scale**

1:250 @ A1 1:500 @ A3

**Status**

For Information

**Drawing Number** **Revision**

**503-PTA-EZ-ZZ-DR-A-1922** **P02**

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