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# 11-12 INGESTRE ROAD, LONDON, NW5 1UX

## Energy Statement – Revision C

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# 11-12 INGESTRE ROAD, LONDON, NW5 1UX
# Energy Statement
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**Registration of Amendments**

| Revision and Date | Amendment Details | Revision Prepared By | Revision Approved By |
|---|---|---|---|
| Rev A 04/07/18 | Updated to address comments from BMP | AK | CB |
| Rev B 13/07/18 | Reference to overheating report updated | AK | CB |
| Rev C 04/09/18 | Reference to National Planning Policy Framework updated | AK | DE |

## EXECUTIVE SUMMARY

Create Consulting Engineers Ltd has been appointed to provide an Energy Statement to support the forthcoming planning application for a proposed Extra Care Development at the site of the former care home at 11 - 12 Ingestre Road, London, NW5 1UX. This report has been developed to detail the energy strategy for the development and demonstrates how it relates to the following guidance documents:

- The London Plan, March 2016:
  - Chapter 5: London's response to climate change;
- Sustainable Design and Construction SPD, February 2009;
- Camden Local Plan, June 2017;
- Camden Planning Guidance CPG 3: Sustainability, July 2015, updated March 2018.

The new build proposal comprises six storey plus single storey basement building accommodating 50 Assisted Living residential apartments with associated communal and support facilities and ancillary cafe, salon and mini gym, together with external amenity spaces, car lift, basement parking, laundry, plant, CCTV, lighting, access, landscaping, infrastructure and other ancillary works.

The energy assessment within the report has been prepared following the principles of the London Plan Energy Hierarchy: 'Be Lean', 'Be Clean' and 'Be Green'.

**'Be Lean':** The strategy aims to reduce energy demands by first incorporating suitable passive design measures, followed by proposed enhancements to provide a highly efficient building fabric and efficient heating system. The proposed energy conservation measures will reduce the new build dwellings' Fabric Energy Efficiency (DFEE) below the Target Fabric Energy Efficiency (TFEE) by **10%.** The Dwellings Emission Rate (DER) and Building Emission Rate (BER) are marginally higher than the Target Emission Rate (TER) figures dictated by the Building Regulations. These have been calculated based on gas heated spaces as required by the GLA's guidance on preparing energy statements. This figure will be revised at detailed design stage when building services design is fully developed. The design will be progressed prioritising energy efficiency of the building fabric and services.

**'Be Clean':** The opportunity for the proposed development to link into an existing or planned decentralised energy network has been considered. The development is not located within immediate proximity of a proposed district heat network, however the design and layout of the building's plant room will be such that it will facilitate the possible future connection of the development to an energy network.

**'Be Green':** A feasibility study has been undertaken to establish the most suitable renewable technology for integration within the proposed development. Air source heat pumps and photovoltaic systems have been deemed the most viable and practical options for the scheme. The proposed heat pumps will provide heating to all spaces and cooling to the non-domestic areas. A PV array of approximately 27kWp for the site is initially proposed to maximise the roof space and energy reduction achieved.

A highly optimised energy strategy based on passive design, building fabric performance and building services systems and controls, and suitable Low and Zero Carbon systems will allow the scheme to achieve an **improvement over Part L 2013 of approximately 21.9%.** The London Plan $CO_2$ emissions reduction requirement (35% Improvement over Part L 2013) is not considered achievable for the scheme due to the practical constraints of the site (limited roof area available for PV).

The table below summarises the energy and $CO_2$ emission reductions for the stages of the energy hierarchy for the proposed Ingestre Road development.

| Carbon Dioxide Emissions – Domestic & Non-Domestic areas | Carbon Dioxide Emissions [tonnes/year] (tonnes $CO_2$ per annum) | |
|---|---|---|
| | Regulated | Unregulated |
| **Baseline: Part L 2013 of the Building Regulations Compliant Development (community gas – GLA guidance)** | 184.42 | 252.64 |
| **Be Lean - energy demand reduction** | 190.87 | 252.64 |
| **Be Green - ASHP** | 154.68 | 252.64 |
| **Be Green – 27kWp PV** | 144.04 | 252.64 |
| **Improvement over Part LA: 2013** | 40.38 | **Tonnes $CO_2$ per annum** |
| | **21.90** | **%** |

**Copy of Table 5.5: Energy hierarchy reductions – Whole development**

The ‘zero carbon’ target has not been achieved for the proposed residential part of the development on-site therefore the Client will commit to meeting the shortfall by making contributions to the Camden Council carbon offsetting fund. The funds secured by the council will be ring-fenced to deliver carbon emissions savings off site through a variety of projects and will be secured through Section 106 legal agreements.

# 1.0 INTRODUCTION

1.1 Create Consulting Engineers Ltd has been commissioned by Four Quarters (Ingestre Road) Ltd to produce an Energy Statement to support the planning application for a proposed Extra Care Development at the site of the former care home at 11 - 12 Ingestre Road, London NW5 1UX.

**Site Location and Description**

1.2 The former Ingestre Road Care Home for the Elderly (C2 Use Class) included 48 self-contained bedrooms for residents. It closed in 2013, when the then residents were relocated to more modern and fit for purpose elderly person's accommodation at Maitland Park.

1.3 The Site is located at 11 - 12 Ingestre Road in the London Borough of Camden. Please refer to Figure 1 below for site location.

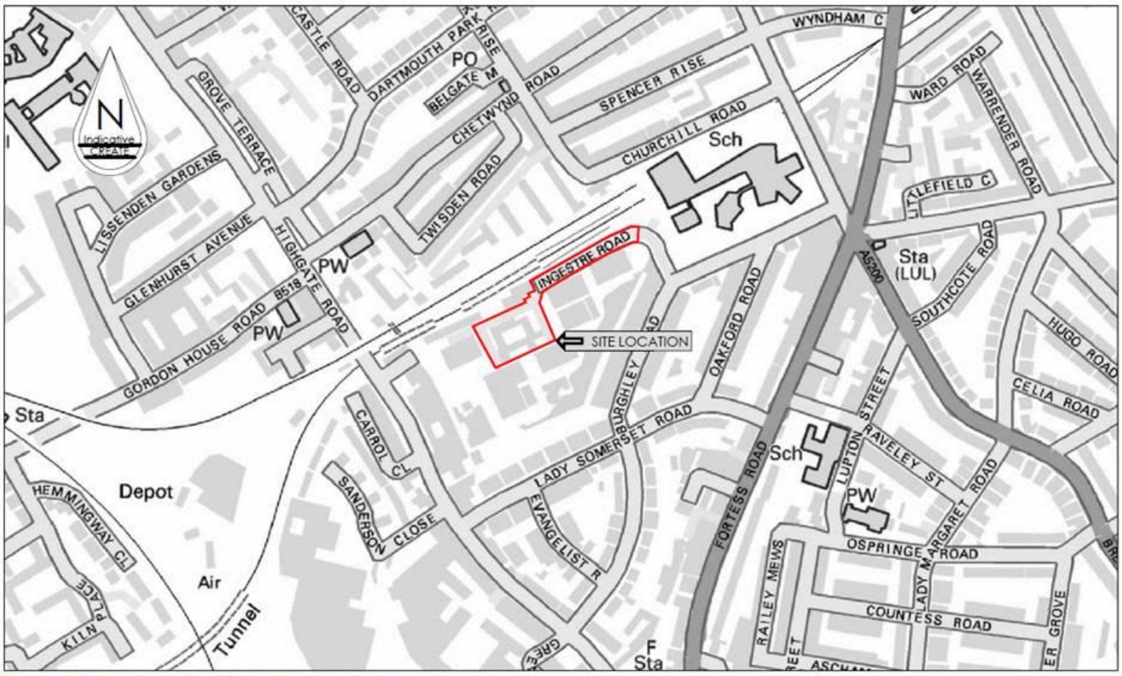



**Figure 1: Site location plan**

1.4 The site is surrounded by residential buildings and is located in close proximity to Tufnell Park tube station to the east and Kentish Town tube station to the south-east. Hampstead Heath Park is located approximately 500 meters to the north-west of the site.

**Proposed Development**

1.5 The proposal comprises demolition of existing buildings and the erection of a six storey, plus single storey basement, building accommodating 50 Assisted Living residential apartments with associated communal and support facilities and ancillary cafe, salon and mini gym, together with external amenity spaces, car lift, basement parking, laundry, plant, CCTV, lighting, access, landscaping, infrastructure and other ancillary works.

1.6 This report details information gathered from consultation with the design team.

**Objectives**

1.7 The objectives of this report are to:

- Demonstrate how the proposed development will meet the policy requirements of the London Borough of Camden and of the London Plan, including its associated Energy Hierarchy (Policy 5.2: 'Minimising carbon dioxide emissions') and Cooling Hierarchy (Policy 5.9: 'Overheating and Cooling').
- Identify the most suitable passive and energy efficient design approach for the scheme, the feasibility of Low and Zero Carbon (LZC) technologies and operational Best Practice.
- Identify the drivers relating to an energy efficient design over and above minimum compliance with current Building Regulations and other appropriate regional and national policies.

**Report Structure**

1.8 This introductory section is followed by a review of national and local current and future policies on energy, good practice review and project requirements. A detailed assessment of the estimated energy consumption and associated carbon dioxide emissions is provided, with passive design measures along with energy efficient equipment. This relates to the 'Be Lean' element of the proposed Energy Hierarchy. Low and Zero Carbon technologies are reviewed in detail for feasibility within the scheme, relating to the 'Be Clean' and 'Be Green' elements of the Energy Hierarchy.

1.9 Section 7 provides a summary and conclusion on the energy strategy for the scheme.

## 2.0 CURRENT AND FUTURE PLANNING POLICIES/GOOD PRACTICE REVIEW AND PROJECT REQUIREMENTS

**National Planning Policy Framework (July 2018)**

2.1 The National Planning Policy Framework sets out the Government's planning policies for England and how these are expected to be applied. Taken together, these policies articulate the Government's vision of sustainable development, which should be interpreted and applied locally to meet local aspirations. The ministerial foreword of this NPPF highlights that 'the purpose of planning is to contribute to the achievement of sustainable development' and that at the heart of the framework is a presumption in favour of sustainable development.

2.2 Sustainable development is defined in the NPPF as comprising developments "meeting the needs of the present without compromising the ability of future generations to meet their own needs" in line with the definition of the Brundtland Commission ('Our Common Future', 1987). The NPPF also refers to the three overarching objectives, which are interdependent and need to be pursued in mutually supportive ways – an economic objective, a social objective and an environmental objective.

**The London Plan, March 2016**

2.3 This Spatial Development Strategy for Greater London includes objectives to reduce the capital's impact on, and exposure to, the effect of climate change. The policies that are appropriate to the Ingestre Road proposals are detailed in the following sections.

<u>Policy 5.2: 'Minimising Carbon Dioxide Emissions'</u>

2.4 Development proposals should make the fullest contribution to minimising carbon dioxide emissions in accordance with the following energy hierarchy:

- *'Be Lean'*: reduction of the energy demand and associated emissions using a passive design approach and high specification plant;
- *'Be Clean'*: further reducing energy demand and associated emissions by incorporating viable Low Carbon technologies;
- **'***Be Green'*: meeting a proportion of the residual demand via renewable energy technologies, where feasible.

<u>Policy 5.6: 'Decentralised Energy in Development proposals'</u>

2.5 Development proposals should evaluate the feasibility of Combined Heat and Power (CHP) systems, and where a new CHP system is appropriate also examine opportunities to extend the system beyond the site boundary to adjacent sites.

2.6 Major development proposals should select energy systems in accordance with the following hierarchy:

1. Connection to existing heating or cooling networks;
2. Site wide CHP network;
3. Communal heating and cooling.

2.7 Potential opportunities to meet the first priority in this hierarchy are outlined in the London Heat Map tool. Where future network opportunities are identified, proposals should be designed to connect to these networks.

Policy 5.7: 'Renewable Energy'

2.8 Within the framework of the energy hierarchy (see Policy 5.2), major development proposals should provide a reduction in expected carbon dioxide emissions through the use of on-site renewable energy generation, where feasible. Major developments should seek to reduce carbon dioxide emissions by at least 20% through the use of on-site renewable energy generation, where feasible.

Policy 5.9: 'Overheating and Cooling'

2.9 Major development proposals should reduce potential overheating and reliance on air conditioning systems and demonstrate this in accordance with the following cooling hierarchy.

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).

**Greater London Authority (GLA) Supplementary Planning Guidance (SPG) on Sustainable Design and Construction (April 2014)**

2.10 This Supplementary Planning Guidance (SPG) provides guidance on what measures developers can include in their building designs and operations to achieve the carbon dioxide and water consumption targets set out in the London Plan. This SPG also provides guidance on how boroughs can take forward the new approaches set out in the London Plan, such as carbon-dioxide off-setting, retrofitting and 'air quality neutral'. This guidance document includes 3 main sections:

- Chapter 2: 'Resource Management' (Land, Site Layout and Building Design, Energy and $CO_2$ emissions, Renewable Energy, Water Efficiency, Materials and Waste, Nature conservation and biodiversity);
- Chapter 3: 'Adapting to climate change and greening the city' (Tackling increased temperature and drought, Increasing green cover and trees, Flooding);
- Chapter 4: 'Pollution Management – Land, Air, Noise, Light and Water'.

Energy and Carbon Dioxide Emission - Mayor's Priorities

2.11 The overall carbon dioxide emissions from a development should be minimised through the implementation of the energy hierarchy set out in London Plan Policy 5.2. To avoid complexity and extra costs for developers, the Mayor will adopt a flat carbon dioxide improvement target beyond Part L 2013 of 35% to both residential and non-residential development. Developers should aim to achieve Part L 2013 Building Regulations requirements through design and energy efficiency alone, as far as is practical.

**Draft New London Plan**

2.12 A draft new London Plan was published by the Mayor for consultation in December 2017. The consultation period ended on 2 March 2018.

2.13 The information published by the Mayor of London states that *"the current 2016 Plan (The London Plan consolidated with alterations since 2011) is still the adopted Development Plan, but the Draft London Plan is a material consideration in planning decisions. The significance given to it is a matter for the decision maker, but it gains more weight as it moves through the process to adoption."*

2.14 Policy SI2 within the proposed Chapter 9: Sustainable Infrastructure confirms the London principles for minimising greenhouse gas emissions. It requires that all developments follow the energy hierarchy and meet the new target of net-zero carbon. This target will be applicable for all developments from 2019, as detailed in already published Guidance on preparing energy assessments (2016). The net-zero carbon target is already applicable to residential development. Please refer to paragraphs below for details.

**Greater London Authority (GLA) guidance on preparing energy assessments (March 2016)**

2.15 The March 2016 revision to the GLA guidance on preparing energy statements clarifies energy targets in the context of Government announcements regarding 'zero carbon' policy.

2.16 *"'Zero carbon' homes are homes forming part of major development applications where the residential element of the application achieves at least 35% reduction in regulated carbon dioxide emissions (beyond Part L 2013) on-site. The remaining regulated carbon dioxide emissions, to 100%, are to be off-set through cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere."*

2.17 The GLA will continue to require that non-domestic development seek to achieve a 35 per cent reduction against Part L 2013.

2.18 The zero carbon target defined above will be implemented for Stage 1 schemes submitted to planning authorities on or after 1 October 2016.

2.19 To summarise, the emission reduction targets that the GLA will apply to applications are as follows:

- Stage 1 schemes received by the Mayor on or after the 1st October 2016 – **'Zero carbon' (as defined above) for residential development and 35% below Part L 2013 for commercial development**

**Camden Local Plan Adoption version (June 2017)**

Policy D1 Design

2.20 The Council will require that development is sustainable in design and construction, incorporating best practice in resource management and climate change mitigation and adaptation plus is of sustainable and durable construction and adaptable to different activities and land uses.

Policy CC1 Climate Change Mitigation

2.21 *"The Council will require all development to minimise the effects of climate change and encourage all developments to meet the highest feasible environmental standards that are financially viable during construction and occupation."*

2.22 *"The council will promote zero carbon development and require all development to reduce carbon dioxide emissions through following the steps in the energy hierarchy and will require all major development to demonstrate how London Plan targets for carbon dioxide emissions have been met."*

2.23 *"The Council will expect developments of five or more dwellings and/or more than 500 sqm of any gross internal floor space to achieve a 20% reduction in carbon dioxide emissions from on-site renewable energy generation (which can include sources of site related decentralised renewable energy), unless it can be demonstrated that such provision is not feasible."*

2.24 The policy also requires that all major developments are supported by an energy statement which will demonstrate that the London Plan energy hierarchy is adhered to.

**Camden Planning Guidance CPG 3: Sustainability (July 2015, updated March 2018)**

2.25 The document supports the policies in Camden's Local Development Framework. The CPG provides information on ways to achieve carbon reductions and more sustainable developments. It details the information that should be included in energy statements and further explains the energy hierarchy that should be applied to all developments.

**Building Regulations Approved Document Part L1: 2013**

2.26 Part L of the current Building Regulations considers the reduction of carbon emissions in new and existing buildings. The proposals for the site consist of the creation of new non-domestic areas and dwellings. The new dwellings fall under Part L1A and the new non-domestic areas under Part L2A of the Building Regulations (Conservation of fuel and power in new dwellings).

2.27 The overall structure of compliance with the 2013 Building Regulations includes five criteria to comply with for all new residential dwellings:

- **Criterion 1** – The Dwelling Emission Rate/Building Emission Rate (DER/BER) should be better than the Target Emission Rate (TER) and the Dwelling Fabric Energy Efficiency (DFEE) should be better than the Target Fabric Energy Efficiency (TFEE);
- **Criterion 2** - Limit on design flexibility;
- **Criterion 3** - Limiting effects of heat gain in summer;
- **Criterion 4** - Commissioning and air-tightness;
- **Criterion 5** - Efficient operation of buildings.

2.28 The new Building Regulations came into force on 6$^{th}$ April 2014. For new homes, the changes introduced within the new version of Part L1A:2013 will deliver a 6% improvement on the previous 2010 standards across the build mix for residential scheme. The Part L 2013 specifications for non-domestic buildings have been strengthened to deliver 9% carbon dioxide savings across the new non-domestic mix relative to Part L 2010.

2.29 The detailed energy strategy for the scheme will be developed to ensure the scheme meets the relevant requirements of the Building Regulations.

## 3.0 ENERGY EFFICIENCY STRATEGY – 'BE LEAN'

**Introduction**

3.1 The proposed energy strategy has, as its first priority, minimised energy consumption through the performance of the building envelope and services. The following section details the energy efficiency features of the development. The cooling hierarchy set out within the London Plan has been followed.

3.2 This analysis includes:

- Building Regulations Approved Document ADL1A and L2A (2013) initial compliance assessment, identifying the potential for the design to comply with and exceed Building Regulations requirements.
- An energy demand assessment of the proposed scheme contained within this document provides carbon dioxide emissions estimates from the analysis of passive energy efficiency enhancements and Low and Zero Carbon potential. This will utilise Building Regulations 2013 carbon dioxide factors.

3.3 In further detail, the energy efficiency strategy of the scheme has been achieved by incorporating the following design and technology features:

**Energy Efficiency Features Proposed**

Physical Form and Orientation of the Building

3.4 While the orientation of the development is fixed due to it being erected in place of the existing block, the facade of the new block has been optimised in order to provide a balance of thermal control, both from within and outside of the building.

3.5 Passive solar design involves adapting the internal layout and glazing to best respond to the local climate and annual sun path, with the aim of reducing energy demands and improving occupant comfort through the use of heat and light from the sun. All of the flats and non-domestic areas accommodate large windows permitting maximum daylight penetration into the new dwellings.

3.6 Good levels of natural daylight will be achieved for the majority of the scheme. This will reduce reliance on artificial lighting and thus limit energy consumption.

Overheating

3.7 A detailed analysis of overheating has been completed for all habitable areas of the Ingestre Road development by Create Consulting Engineers Ltd and will be submitted in support of this planning application.

3.8 The report concludes that overheating in all kitchen, living rooms and bedrooms within the residential part of the development pass all of the overheating criteria as detailed in TM59: Design Methodology for the assessment of overheating risk in homes. The risk of overheating is reduced through the inclusion of moderate overshading in the form of balconies and as a result of shading provided by the existing residential blocks. Additionally, glazed areas have been designed to maximise openable areas to enable effective ventilation of the rooms.

3.9 It has been identified that some non-domestic areas are at risk of overheating. This occurs largely due to internal gains (lighting and equipment) and auxiliary ventilation gains. Comfort cooling proposed for non-domestic areas as part of the design will ensure thermal comfort in these spaces is achieved.

Building Envelope Specification and Thermal Performance

3.10 Building fabric thermal transmittance is measured by the U-value of each building element in Watts/m²/K. The U-value describes how well a building element conducts heat. It measures the rate of heat transfer through a building element over a given area, under standardised conditions: the lower the U-value, the better the insulating ability. Table 3.1 and 3.2 below detail the U-values for the development at 11-12 Ingestre Road in relation to Building Regulations minimum standards.

| Building Element/Characteristic | Proposed values | Building Regulations Part L1A: 2013 Requirements |
|---|---|---|
| Exterior walls and ground contact walls in basement - U value (W/m²K) | **0.18** | 0.30 |
| Walls to unheated spaces (W/m²K) | **0.18** | |
| Floor over unheated spaces and ground floor | **0.12** | 0.25 |
| Flat Roof - U value (W/m²K) | **0.12** | 0.20 |
| Windows - U value (W/m²K) | **1.3** | 2.0 |
| Doors to unheated areas - U value (W/m²K) | **1.0** | 2.0 |
| Design Air Permeability(m³/hr/m² @50Pa) | **4** | 10 |
| Thermal Bridges | **ACDs where available** | n/a |

**Table 3.1: Proposed building fabric performance for residential units**

Thermal Mass

3.11 Utilising the thermal mass of a building can help to regulate internal temperatures and temper heating and cooling loads by absorbing and radiating heat, thus reducing annual energy consumption. To exploit the thermal mass of the building, either direct or indirect contact is required between the structure and the occupied space, via exposed surfaces or high energy exchange systems. There is limited opportunity to exploit thermal mass indirectly; this is because the internal finishes such as carpets and dry-lining will reduce the effectiveness of the building's structure as an energy store.

3.12 The proposed development, with a concrete frame construction filled with steel stud walls and insulating boards, and finished internally with plasterboard, will have a medium thermal mass.

Air Tightness and Ventilation Strategy

3.13 Air permeability is a measure of infiltration. It indicates how often the entire air quantity in a building is exchanged with outside air within 1 hour without any ventilation in place. Any air exchange with outside air is carrying heat energy away from the building, resulting in a higher heating load. Lower air permeability levels are desirable for conserving heat energy and in the case of mechanical ventilation systems for reducing fan power consumption. Infiltration is different from ventilation. Infiltration is essentially unwanted air exchanges through imperfections in the building fabric while ventilation is the air exchanges intended by the designer.

3.14 As detailed in Tables 3.1 and 3.2 the air permeability of the proposed development has been assumed to be 4 $m^3/m^2$@50PA/hr for all dwellings.

3.15 All the residential units will utilize natural ventilation with trickle vents and extractor fans to all kitchens and wet rooms.

3.16 The ventilation system proposed for the non-domestic areas is via mechanical ventilation with heat recovery (MVHR) with high efficiency in the region of 80% and low SFP (specific fan power) to limit energy use. The chosen system will be fitted with $CO_2$ sensors modulating air flow based on space occupancy. The exact make and model will be confirmed at detailed design stage.

London Plan Cooling Hierarchy

3.17 The section above details how the different measures that have been recommended have followed the London Plan cooling hierarchy developed in Policy 5.9 – 'Overheating and Cooling'.

3.18 In summary, they will:

- Minimise internal heat generation through energy efficient design & reduce the amount of heat entering a building in summer through orientation, shading, albedo, fenestration and insulation:
    - Optimised solar transmittance of the glazing units (g-value 0.4 - 0.5);
    - Overhangs in form of balconies.

3.19 Furthermore, the buildings will incorporate:

- Mechanical ventilation
    - High efficiency Mechanical Ventilation with Heat Recovery (MVHR) for non-domestic spaces;
- Active cooling systems (ensuring they are the lowest carbon options)
    - Provided in the gym, fitness room, reception area and lounge, café, hairdressers and all hobby rooms.
    - Based on the results of the thermal modelling study, comfort cooling will be considered for the flats with high risk of overheating.

Lighting and Appliances

3.20 High efficiency low energy lighting and controls have been specified throughout. All residential spaces will utilise 100% low energy lighting. The lighting controls in most of the communal spaces will comprise occupancy sensing switches with daylight dimming function fitted to some of the rooms.

3.21 Highly efficient lighting has been proposed for the commercial part of the scheme: > 60 luminaire lumens per circuit watts with occupancy sensing and/or daylight dimming controls (parasitic power of 0.05 $W/m^2$).

3.22 Power factor correction equipment will be installed (Power Factor > 0.95) resulting in a reduced demand being placed upon the grid.

3.23 The commercial areas will be fitted with sub-metering for all major energy loads, including lighting and heating to allow the facilities manager to accurately track consumption and to adjust building use accordingly.

3.24 Lighting has been designed in accordance with CIBSE (Chartered Institute of Building Service Engineers) Guide A: Environmental Design and ILP (Institute of Lighting Professionals) Guidance for the Reduction of Obtrusive Light. The former describes recommended lux levels within various spaces (i.e. Bedroom, Living Room etc.) whilst the latter provides guidance on minimising obtrusive light.

3.25 Unnecessary light spill will be reduced by avoiding the use of external decorative lighting; providing fittings only where they are required for security and maintenance purposes. External luminaires have been chosen to minimise sky glow and overspill and located to ensure that only the level of lighting that is required is achieved.

3.26 A simple building user guide on the operation and environmental performance of the building and systems will be developed for the occupant and non-technical building manager.

3.27 All appliances, if provided, will be very energy efficient (A to A+++ rated). Information on the EU Energy Efficiency Labelling Scheme will be provided in the assisted living dwelling.

The Choice and Design of Building Systems and Plant

3.28 The building systems and plant have been designed by McKee Associates to optimise the efficiency of the systems by matching installed capacity to anticipated building demand. Items of equipment, which make up the building's mechanical building services installation, will be specified to achieve high annual energy efficiency in operation and will be serviced regularly to maintain their performance.

3.29 The proposed method of supplying heating and hot water to the dwellings will be via community air source heat pumps (ASHP). Each flat will be separately sub-metered. Space heating will be provided via underfloor heat distribution pipes in lounge, dining area, kitchen and bathrooms, and via low temperature radiators in bedrooms. The efficiency of the proposed system will be in the region of 350-400% and the heating system will be controlled by a programmer and TRVs.

3.30 All non-domestic areas will be heated by reverse cycle heat pumps that will also provide cooling to some of the spaces. The access corridors to all flats will be heated by fan assisted radiators linked to the community heating system.

**Carbon Dioxide and Energy Reductions - Part L1A compliance – Residential units**

Standard Assessment Procedure and GLA Guidance

3.31 The Standard Assessment Procedure (SAP 2012) which formed the basis for demonstrating dwelling compliance with Part L1 of the Building Regulations 2013 for new dwellings has been used for the development at Ingestre Road to estimate the savings achieved through the energy efficiency features proposed and to predict the annual $CO_2$ emissions of the dwellings (using NHER Plan Assessor version 6.2.3 – Part L1A certified compliance software). The $CO_2$ emissions of the unregulated elements (cooking and appliances) have been estimated based on the methodology developed in Appendix L of SAP 2012.

3.32 The GLA guidance on preparing energy assessments clarifies the calculation methodology for residential and non-domestic developments to ensure the consistency of the calculations across all boroughs.

3.33 The energy assessment must first establish the regulated $CO_2$ emissions assuming the development complies with Part L 2013 of the Building Regulations. When determining this baseline, it should be assumed that the heating would be provided by gas boilers and that any active cooling would be provided by electrically powered equipment.

3.34 The 'Be Lean' case should assume that the heating is provided by gas boilers and that any active cooling would be provided by electrically powered equipment. The boilers should be assumed to have an efficiency of 89.5% for residential and controls aligned with the Part L notional building assumptions. This is to demonstrate the $CO_2$ emissions savings achieved through incorporation of passive design and efficient building fabric.

Dwellings modelled

3.35 A sample of representative dwellings has been modelled for the re-developed scheme based on the latest set of architectural drawings from Barton Willmore.

- A-1-01 MF end terrace x 17
- A-1-02 MF mid terrace x 5
- A-2-05 2 bed above non-domestic heated space x 6
- A-4-01 2 bed heat loss roof x 8
- A-4-02 2 bed mid terrace heat loss roof x 2
- A-5-01 2 bed TF x 6
- A-5-04 2 bed TF with glazed/paneled walls x 2
- A-G-01 GF 2 bed end terrace x 2
- A-G-02 GF 2 bed mid terrace x 1
- A-G-04 GF 1 bed x 1

Results of the $CO_2$ emissions estimation – 'Be Lean' case

3.36 The total $CO_2$ emissions been estimated based on the results from the energy modelling for the proposed dwellings. Please refer to Table 3.2 below:

| Carbon Dioxide Emissions – Energy Hierarchy | Carbon Dioxide Emissions [tonnes/year] | |
|---|---|---|
| | **Regulated** | **Unregulated** |
| **Baseline: Part L 2013 of the Building Regulations Compliant Development (community gas – GLA guidance)** | 62.4 | 56.75 |
| **Be Lean - After energy demand reduction** | 62.94 | 56.75 |
| **Improvement over Part LA: 2013** | **-0.63** | **Tonnes $CO_2$ per annum** |
| | **-1** | **%** |

**Table 3.2: $CO_2$ emissions and energy consumption for the 'Be Lean' case**

3.37 The estimated $CO_2$ emissions calculated for the 'Be Lean' scenario are higher than the target emissions for the dwellings. This is largely due to the assumptions for efficiencies of heating and cooling system and lack of accredited construction details for majority of party walls thermal bridging junctions.

3.38 It has been demonstrated, however, that the optimised building fabric specified for the dwellings has led to an overall projected improvement over Part L Fabric Energy Efficiency (FEE) standard of **over 10%.** Please refer to Tables 3.4 below for summary of the results and Appendix A for detailed SAP calculations.

| Dwelling Type | Multiplier | Floor Area ($m^2$) | Target Fabric Emission Efficiency (TFEE) ($kWh/m^2/yr$) | Dwelling Fabric Energy Efficiency (DFEE) ($kWh/m^2/yr$) | Improvement over PartL1A:2010 - 'Be Lean' TFEE criteria |
|---|---|---|---|---|---|
| A-1-01 MF end terrace | 17 | 74.40 | 40.51 | 39.93 | **1.4%** |
| A-1-02 MF mid terrace | 5 | 76.52 | 27.85 | 25.72 | **7.6%** |
| A-2-05 2 bed above non-domestic | 6 | 88.78 | 47.48 | 36.04 | **24.1%** |
| A-4-01 2 bed heat loss roof | 8 | 74.40 | 42.07 | 40.98 | **2.6%** |
| A-4-02 2 bed mid terrace heat loss roof | 2 | 76.52 | 30.85 | 25.92 | **16.0%** |
| A-5-01 2 bed TF | 6 | 86.50 | 54.74 | 43.01 | **21.4%** |
| A-5-04 2bed TF glazed walls | 2 | 72.67 | 58.27 | 58.29 | **0.0%** |
| A-G-01 GF 2 bed end terrace | 2 | 74.40 | 62.65 | 56.59 | **9.7%** |
| A-G-02 GF 2 bed mid terrace | 1 | 76.52 | 47.15 | 40.44 | **14.2%** |
| A-G-04 GF 1 bed | 1 | 54.41 | 49.31 | 39.75 | **19.4%** |
| **Average - Area Weighted per dwelling type** | | | 42.87 | 38.55 | **10.08%** |

**Table 3.3: Improvement over Part L – FEE criterion – energy efficiency features only**

3.39 It is worth noting that due to the current calculation methodology used for Part L compliance and the GLA Energy Assessment methodology, the $CO_2$ savings achieved through the provision of energy efficient appliances (unregulated loads) are not included, hence the $CO_2$ savings presented in this report are considered to be conservative. The unregulated $CO_2$ emissions have been considered similar for all the different stages of the London Plan energy hierarchy. It is however expected that this scheme will lead to unregulated $CO_2$ emissions significantly lower than those of a standard Part L 2013 compliant scheme.

**Carbon Dioxide and Energy Reductions - Part L2A compliance – Non-domestic areas**

<u>IES Thermal Modelling</u>

3.40 IES VE uses National Calculation Methodology (NCM) and SBEM platform to demonstrate building compliance for non-residential buildings with Part L2A of the Building Regulations 2013. These calculations have been used to estimate the energy efficiency features required for Part L compliance, as well as to predict the annual building regulated energy demand, consumption and $CO_2$ emissions of the community areas.

3.41 The SBEM calculations determine a Building Emissions Rate or 'BER'. This value is compared to the energy requirements and emissions of a notional building of the same shape and dimensions which determines a compliant building (the Target Emission Rate or 'TER'). The BER must be equal to or less than the TER.

3.42 Following the GLA guidance on preparing Energy Statements, when determining the building's baseline, it should be assumed that the heating would be provided by gas boilers (91% efficient) and that any active cooling would be provided by electrically powered equipment. The non-domestic areas have been modelled to follow this guidance.

Results of the $CO_2$ emissions estimation – 'Be Lean' case

3.43 The total $CO_2$ emissions has been estimated based on the results from the energy modelling for the proposed community areas. Please refer to Table 3.4 below:

| Carbon Dioxide Emissions – Non-domestic spaces | Carbon Dioxide Emissions [tonnes/year] | |
|---|---|---|
| | Regulated | Unregulated |
| **Baseline: Part L 2013 of the Building Regulations Compliant Development (community gas for heating, ASHP for cooling – GLA guidance)** | 122.02 | 195.89 |
| **Be Lean - After energy demand reduction (better efficiencies for cooling and mechanical ventilation)** | 127.93 | 195.89 |
| **Improvement over Part LA: 2013** | **-5.91** | **Tonnes $CO_2$ per annum** |
| | **-4.8** | **%** |

**Table 3.4: $CO_2$ emissions and energy consumption for the 'Be Lean' case**

3.44 The estimated $CO_2$ emissions calculated for the 'Be Lean' scenario are higher than the target emissions for the gas heated spaces. It has been identified that the highest energy consumption by end use is in area of hot water supply and lighting. This is largely due to the assumptions for heating and lighting controls and heat distribution losses made at this stage of the design. These areas will be addressed and optimised at detailed design stage. A full lighting design will provided to optimise the system's performance and to ensure accuracy of the modelling.

**Conclusions**

3.45 To achieve the Camden Local Plan and London Plan Policy 5.7 target of 35% $CO_2$ emissions reduction for the scheme, the proposed development will incorporate renewable or low carbon technology. A feasibility study of different renewable systems to determine their suitability for the scheme is presented in Section 5 of this report.

## 4.0 'BE CLEAN': SUPPLY ENERGY EFFICIENTLY

4.1 Connection to a decentralised energy network and the use of combined heat and power is a recognised method of generating energy more efficiently. The London Plan Policy 5.5: 'Decentralised Energy Networks' and Camden Council Policy CC1: 'Climate change mitigation' require development proposals to explore the opportunities to link into an existing or planned decentralised energy network using the London Heat Map tool. Where an existing decentralised energy network is not present, an assessment of the feasibility of establishing a decentralised energy system for the proposed development should be undertaken; including an assessment of the feasibility of a Combined Heat and Power (CHP) communal heating system.

4.2 The feasibility of connecting to an existing network and specification of a Combined Heat and Power system has been assessed within the following section.

**Decentralised Energy Networks**

4.3 The London Heat Map tool is an interactive tool that allows users to identify opportunities for decentralised energy projects in London. It builds on the 2005 London Community Heating Development Study. All information has been updated and the map is now in a user friendly format using an interactive GIS system. This tool details the existing and proposed major heat loads and supplies within London as well as existing and proposed heat distribution networks.

4.4 The London Heat Map tool indicates the location of a future decentralised energy network approximately 3 kilometres from the Ingestre Road site (Please refer to Figure 4.1). The site is not located within a viable distance of the heat networks; therefore connection to a decentralised energy network is considered unfeasible at the present time.

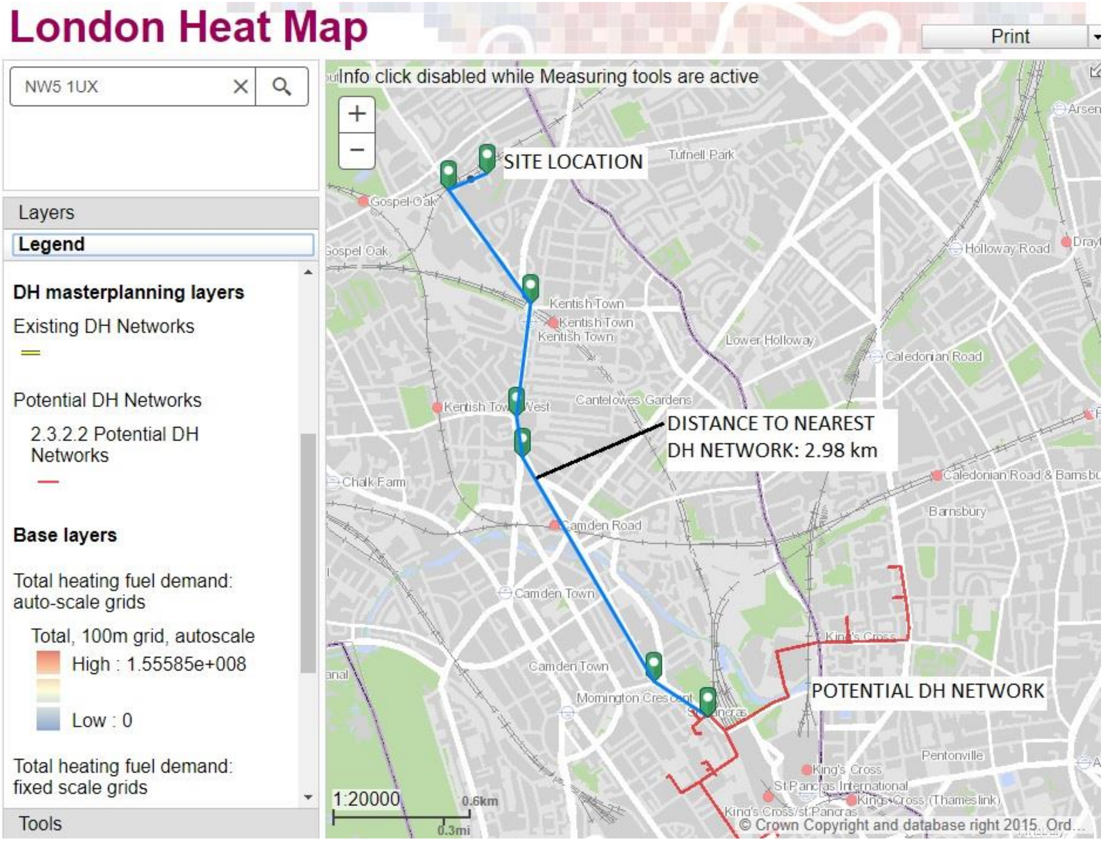


**Figure 4.1: Location of the proposed site in relation to potential energy networks.**

4.5 However, the development will utilise a central communal heating system, distributing a heating flow to the residential units. The use of a communal heating system is a pre-requisite for the possible connection of the building's heating system to a decentralised energy network at a later date. The heat source would utilise sequenced high efficiency air source heat pumps.

4.6 The plant rooms will be approximately 125m² total in size, located in the basement. The design and layout of the building's plant room will be such that it will facilitate the possible future connection of the development to an energy network. Please refer to figure 4.2 for location of the proposed plant rooms.

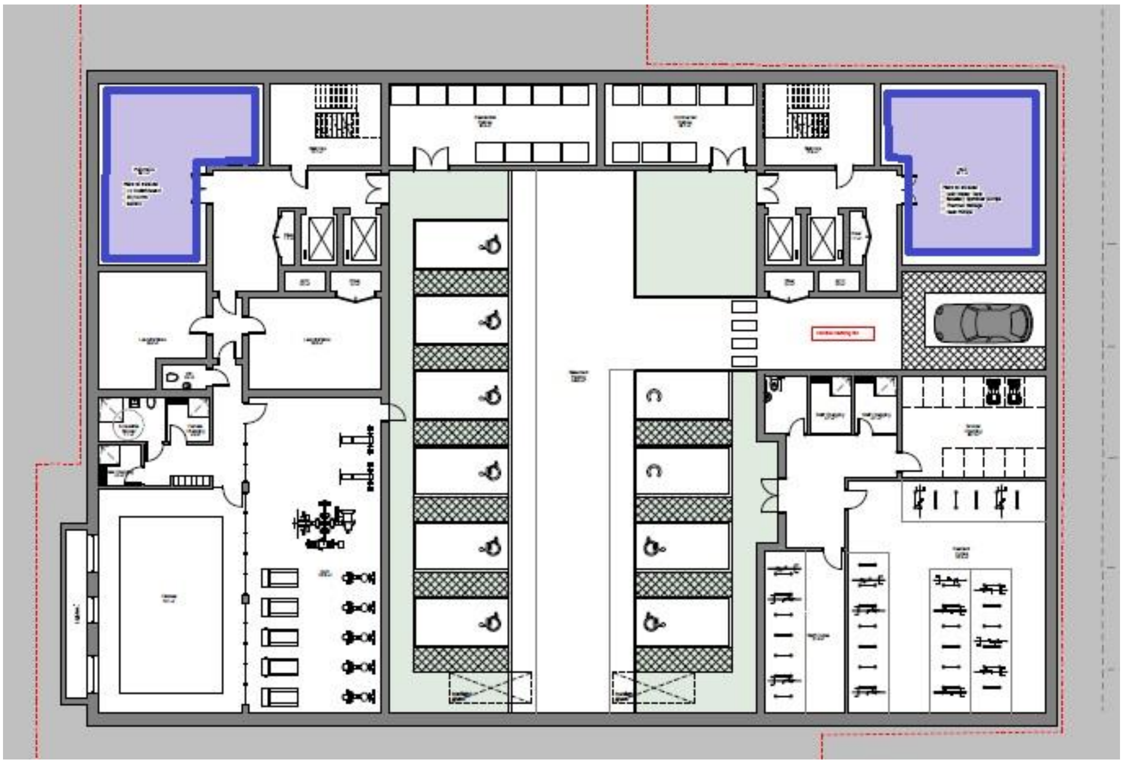

**Figure 4.2: Location of basement plant rooms (based on drawing by Barton Willmore)**

4.7 The following design features will be included in the proposed heating system design to allow for future connections to a district heating system:

- Reservation of space for a valve pit at site boundary (1.2m x 1.2m x 1.0m high);
- Reservation of space in riser ducts for future district heating flow and return pipes (estimated pipe diameter - 150mm with thermal insulation);
- Reservation of space in the basement plant rooms for future heat exchange equipment.

## 5.0 'BE GREEN': USE RENEWABLE ENERGY

5.1 The final step in the energy hierarchy requires that the clean generation of energy by renewable energy technologies be examined. The London Plan Policy 5.7: 'Renewable Energy' and London Borough of Camden Local Plan Policy CC1: 'Climate change mitigation' require the incorporation of on-site renewable energy generation to provide a percentage reduction in the carbon emissions from the proposed development. The London Plan requires all developments to achieve a 'reduction in carbon dioxide emissions of 20% from on-site renewable energy generation unless it can be demonstrated that such provision is not feasible'.

5.2 ASHPs are considered the most suitable option for providing heating and cooling to the development. This strategy has been adopted after a consultation with the appointed M&E engineer. The advice from the M&E consultant confirmed that CHP heating system, if installed in the building, would not be fully utilised based on the planned use of the spaces and therefore would result in inefficient running of the unit. Community gas boiler would not provide any carbon reduction over the Building Regulations compliant case.

5.3 For these reasons the Client's preferred option for reducing carbon dioxide emissions is through the application of community air source heat pumps (ASHP) and photovoltaic panels (PV) to the roofs of the newly constructed block.

**Proposed Renewable Technology – ASHP**

5.4 Heat Pumps, utilising low grade heat, provide high efficiency, low carbon heating. They are a thermodynamic device based on the vapour compression cycle. The four elements of the refrigeration circuit are: the evaporator, compressor, heat exchanger and condenser. The heat, which is extracted from the medium goes through a number of processes, and is distributed throughout individual dwellings through a standard wet central heating system. Heat pumps utilise electricity to drive their pumps and compressor units. They are essentially a form of efficient electric heating. The efficiency of a heat pump is rated by its coefficient of performance (CoP).

5.5 The CoP is a measure of the electricity input to the system and the heat energy extracted. Several factors affect the CoP of a heat pump; the consistency of the heat source and the required output temperature. A consistent heat source (such as the ground) will deliver greater efficiencies than a heat source that varies seasonally. Also, heat pump efficiency is greatest when the required output temperature rise is lowest; hence heat pumps are commonly paired with under floor heating systems that require lower flow temperatures than conventional radiator emitters.

5.6 Air Source Heat Pumps (ASHP) will be used to provide heating for the domestic and non-domestic areas of the development. Community areas will also utilise reverse cycle heat pumps to provide cooling for these spaces.

5.7 Air Source Heat Pumps extract energy from air and therefore require space for external units. The roof of the proposed block is suitable for location of the external units of the system. It is proposed that between 6 and 10 Mitsubishi Ecodan heat pumps with heating CoP of 3.50 will be fitted on the building. The estimated cooling efficiency will be in a region of EER >=5.

5.8 The heat distribution will be via underfloor pipe system and low temperature radiators in residential areas and access corridors. Non-domestic areas will be served by terminal units concealed in the suspended ceiling.

5.9 Carbon emissions savings achieved by the proposed ASHPs have been calculated in line with the GLA guidance on preparing energy statements and have been compared to a gas heated development to ensure the consistency of calculations in all boroughs is achieved.

5.10 Heat pumps use electricity, which has a higher carbon emission factor than natural gas, and therefore the savings achieved are more conservative than the savings that would have been achieved if the system was compared to a conventional electric heating. Please refer to tables 5.1 and 5.2 for details of the savings achieved by the proposed ASHP.

| Carbon Dioxide Emissions – Domestic areas | Carbon Dioxide Emissions [tonnes/year] | |
|---|---|---|
| | **Regulated** | **Unregulated** |
| **Baseline: Part L 2013 of the Building Regulations Compliant Development (community gas – GLA guidance)** | 62.4 | 56.75 |
| **Be Lean - energy demand reduction** | 62.94 | 56.75 |
| **Be Green - ASHP** | 42.55 | 56.75 |
| **Improvement over Part LA: 2013** | 19.85 – 0.63 (difference between BR and Be Lean; needed to meet BR) = **19.22** | **Tonnes $CO_2$ per annum** |
| | **30.80** | **%** |

**Table 5.1: Energy hierarchy reductions – Residential areas**

| Carbon Dioxide Emissions – Non-domestic spaces | Carbon Dioxide Emissions [tonnes/year] | |
|---|---|---|
| | **Regulated** | **Unregulated** |
| **Baseline: Part L 2013 of the Building Regulations Compliant Development (community gas – GLA guidance)** | 122.02 | 195.89 |
| **Be Lean - energy demand reduction** | 127.93 | 195.89 |
| **Be Green - ASHP** | 105.68 | 195.89 |
| **Improvement over Part LA: 2013** | 16.34 – 5.91 (difference between BR and Be Lean; needed to meet BR) = **10.43** | **Tonnes $CO_2$ per annum** |
| | **8.54** | **%** |

**Table 5.2: Energy hierarchy reductions – Non-domestic areas**

5.11 Total $CO_2$ emissions reduction over the Building Regulations achieved through incorporation of ASHPs are estimated to be 30.8% and 8.54% for domestic and non-domestic areas respectively. The calculations take into account the contribution of the proposed heat pumps to help the spaces meet the Building Regulations in the first instance. The remaining reduction achieved by the system counts towards the carbon reduction from renewable sources.

5.12 The London Plan requirement to reduce $CO_2$ emissions over the Building Regulations by 35% has been targeted for all areas. The proposed ASHP will not suffice to meet the policy target and therefore additional LZC technology has been considered for the scheme.

5.13 The client's preferred renewable technology to compliment the proposed ASHP is photovoltaic panels system. Its suitability and energy reduction achieved is further demonstrated in paragraphs below.

## Proposed Renewable Technology – PV panels

5.14 Photovoltaic cells directly convert sunlight into electrical current using semiconductors. The output of a cell is directly proportional to the intensity of the light received by the active surface of the cell. The location and positioning of PV cells is therefore critical to achieving acceptable performance. Exposure to sunlight causes electricity to flow through the cells. Mono-crystalline PV cells provide higher levels of electricity generating performance over other panel types. PV panels can be incorporated into a range of building designs and positions, provided they are located in a shade-free environment and facing as close to south as possible.

5.15 Photovoltaics are generally technically suitable for all types of developments. Their use can be limited due to their high capital cost. However, with the introduction of the Feed in Tariff, the high capital cost could be balanced with the running cost savings and the fixed tariff offered during a set period of time.

5.16 The following issues are considered in relation to the feasible integration of PV:

- Low maintenance;
- Simple installation;
- Self-cleaning if tilted at an angle of 10 degrees or more;
- Photovoltaic panels are typically straightforward to integrate into a building's services strategy and would not conflict with an ASHP installation;
- Performance output and emissions reduction is greater for PV over solar thermal systems for this arrangement, panel area and specific project loads;
- Access issues;
- Lift overrun / Access hatch/ services termination;
- Improved Return on Investment and payback periods due to Feed-In Tariffs.

5.17 Areas of PV modules vary between manufacturers, however on average a 1 PV module covers an area of approximately 1.5m$^2$. PV panels are produced in various sizes with power outputs ranging from 0.165kWp to 0.3kWp per module. The most commonly used modules in domestic application generate approximately 0.2-0.25kW of electricity.

5.18 The available roof area suitable for locating the PV panels is constrained by the orientation and roof layout of the development. Additionally, a deduction for access, man safe systems and services termination should be included. As a 'rule of thumb' a usable roof area is 75% of the available roof area for the block.

5.19 The aim is to maximise the size of the proposed PV system and therefore as much roof area as possible will be utilised for the installation of the solar collectors. Please see the roof layout below for indicative location of PV panels.

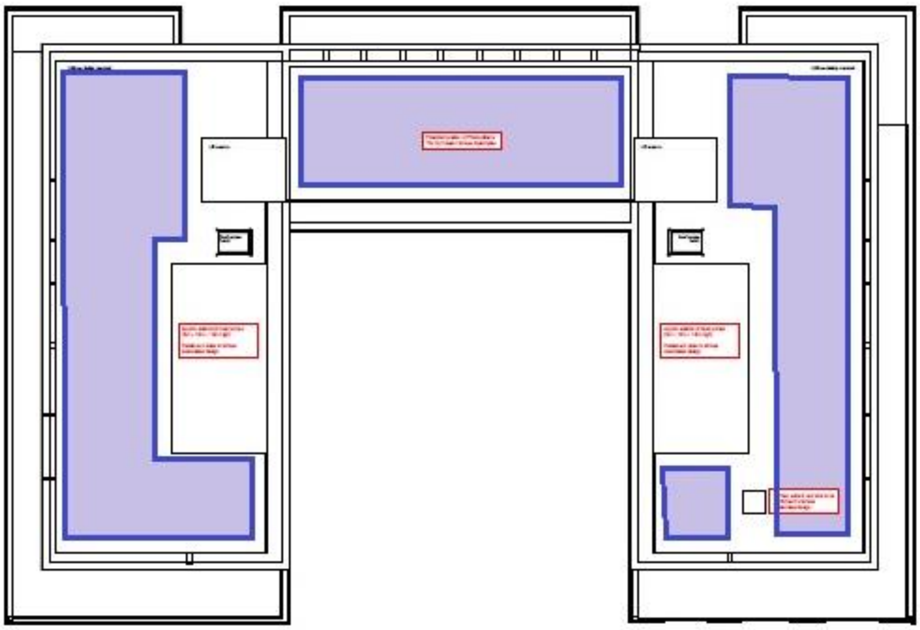

**Figure 5.1: Indicative PV panels layout on flat roofs (based on drawing by Barton Willmore)**

5.20 The calculation below is based on good practice that estimates that a 1kWp PV system laid horizontally requires a spatial area of 12m$^2$ (this takes into account access and shading requirements for panels at max. 15° inclination).

5.21 It has been calculated that usable roof area and maximum size of the PV system for the development is as follow:

- Usable roof area: approx. 435m$^2$ x 75% = 324m$^2$
- Estimated max size of PV system: 324/12 = 27kWp

5.22 Based on calculation methodology included in SAP 2012 document, 1kWp of PV in a horizontal position generates approximately 760kWh of electricity per year, which translates to 394kg of $CO_2$ savings per year.

Predicted PV system size to meet London Plan target the scheme

5.23 The London Plan policy target of 35% $CO_2$ reduction over the Building Regulations for the development would require installation of a minimum of 88.6kWp PV system on the roof of the proposed building, as detailed in table 5.3

| Carbon Dioxide Emissions – Domestic & Non-domestic spaces [tonnes/year] | Carbon Dioxide Emissions (tonnes $CO_2$ per annum) | |
|---|---|---|
| | **Regulated Domestic** | **Regulated Non-domestic** |
| **Baseline: Part L 2013 of the Building Regulations Compliant Development (community gas – GLA guidance)** | 62.4 | 122.02 |
| **Be Lean - energy demand reduction** | 62.94 | 127.93 |
| **Be Green - ASHP** | 42.55 | 105.68 |
| **Improvement over Part LA: 2013** | 19.85 – 0.63 (to meet BR) = 19.22 | 16.34 – 5.91 (for BR) = 10.43 |
| | 30.80% | 8.54% |
| **35% over BR target (London Plan)** | 0.35 x 62.4 = 21.84 | 0.35 x 122.02 = 42.71 |
| **$CO_2$ to be offset by PV** | 21.84 – 19.22 = 2.62 | 42.71 – 10.43 = 32.28 |
| **Total $CO_2$ to be offset by PV** | 34.9 | |
| **$CO_2$ emissions saved by 1kWp horizontally laid PV facing South** | 0.394 | |
| **PV needed for residential part to meet 35% $CO_2$ emissions reduction –** used for 'zero carbon' offset payment calculations (see section 6) | 2.62/0.394 = 6.65 kWp | |
| **Total PV needed for the scheme** | **34.9/0.394 = 88.58 kWp** | |

**Table 5.3: PV needed to achieve London Plan policy target**

5.24 The maximum calculated size of the PV system that could be fitted on the roof will be confirmed at detailed design stage, taking into account the appointed installer's calculations to allow for local wind speed and additional safety access to the PV panels. It is however estimated that the available roof area will not suffice for the PV system calculated above.

Feasible PV system size for the development and $CO_2$ reduction achieved

5.25 If the flat roof of the development is fitted with PV to its maximum, the estimated size of the system will be 27kWp (please refer to paragraphs 5.18-5.21 for calculations). This translates to approximately 108 panels fitted at 10-15 degrees. System of this size would generate circa 20.5 MWh of electricity per year, offsetting approximately 10.64 tonnes of $CO_2$ each year. Please refer to the table 5.4 & 5.5 below for detailed calculations.

| Ingestre Road development | Carbon Dioxide Emissions |
|---|---|
| | **Regulated Domestic and Regulated Non-domestic** |
| **Baseline: Part L 2013 of the Building Regulations Compliant Development (community gas – GLA guidance) [tonnes/year]** | 184.42 |
| **Be Lean - energy demand reduction [tonnes/year]** | 190.87 |
| **Be Green - ASHP [tonnes/year]** | 148.23 |
| **Improvement over Part LA: 2013 [tonnes/year]** | 36.19 – 6.45 (to meet BR) = 29.74 |
| | 16.13% |
| **$CO_2$ emissions saved by 27kWp horizontally laid PV facing South [tonnes/year]** | 27 x 0.394 = 10.64 |
| **Total reduction achieved [tonnes/year]** | 29.74 + 10.64 = **40.38** |
| **Total reduction achieved [%]** | **21.90** |

**Table 5.4: $CO_2$ reductions achieved for the scheme with 27kWp PV system**

| Carbon Dioxide Emissions – Domestic & Non-Domestic areas | Carbon Dioxide Emissions (tonnes $CO_2$ per annum) | |
|---|---|---|
| | **Regulated** | **Unregulated** |
| **Baseline: Part L 2013 of the Building Regulations Compliant Development (community gas – GLA guidance)** | 184.42 | 252.64 |
| **Be Lean - energy demand reduction** | 190.87 | 252.64 |
| **Be Green - ASHP** | 154.68 | 252.64 |
| **Be Green – 27kWp PV** | 144.04 | 252.64 |
| **Improvement over Part LA: 2013** | 40.38 | **Tonnes $CO_2$ per annum** |
| | **21.90** | **%** |

**Table 5.5: Energy hierarchy reductions – Whole development**

5.26 A highly optimised energy strategy based on passive design, building fabric performance and building services systems and controls, and suitable Low and Zero Carbon systems will allow the **whole scheme to achieve an improvement over Part L 2013 of approximately 21.90%.** The increase in $CO_2$ emissions reduction has not been considered achievable for the scheme due to the practical constraints of the site (limited roof area available for PV).

5.27 The reduction in total $CO_2$ emissions has been fully achieved by the proposed LZC technologies, therefore **the requirements of the London Plan Policy 5.7 (20% $CO_2$ reduction from renewable sources) has been met.**

5.28 The energy strategy of the scheme has considered measures to adapt and mitigate effects of climate change, in particular through an optimised design minimising risk of overheating (compliant with the London Plan Cooling Hierarchy) and the specification of energy efficiency systems and LZC leading to significant $CO_2$ emission reductions **(40.38 tonnes of $CO_2$/yr).**

**Other Technologies Considered in the Study**

| | |
|---|---|
| **Solar Thermal Hot Water Panels** | **Not Suitable** |

5.29 Solar hot water systems (SHW) use the energy radiated by the sun and convert it into useful heat in the form of hot water.

5.30 Heat is transferred and stored in a central thermal store. The solar panel system would ideally supply approximately 45-55% of the developments domestic hot water requirement; the remainder of energy required for domestic hot water would be supplied by the gas boilers.

5.31 Solar thermal panels are ideal for dwellings with a highly insulated building envelope as the energy demand for heating water is relatively high in comparison to space heating demand.

5.32 The roof of the block is flat and therefore the collectors would have to be mounted on frames tilted at least 30 degrees facing south, south-west or south-east leading to an optimum hot water output. This would result in higher visual impact of the system.

5.33 The roof of the redeveloped blocks has a limited area and will not suffice to accommodate enough solar thermal panels to provide heat for all of the flats within the block.

5.34 A SHW in conjunction with ASHP system would not reduce $CO_2$ emissions by 35% as required by the London Plan Policy 5.2 and therefore an additional technology would have to be incorporated into the design of the blocks, compromising on space and increasing the overall cost of the construction.

5.35 For these reasons a solar hot water system is not recommended for the site.

| Gas CHP (Combined Heat and Power) | Not Suitable |
|---|---|

5.36 A conventionally fuelled CHP system would utilise a prime mover such as a diesel engine or gas turbine to drive an electrical generator. The heat generated by the prime mover during this process would be utilised in a community heating network.

5.37 Gas CHP systems are energy efficient and considered as low carbon technologies. For CHP to be viable, it must run almost continuously and thus requires a permanent heat demand (hence its suitability for swimming pools, hospitals etc).

5.38 The proposed development, with highly insulated building envelope, will not have a high heat demand throughout a year. The heating base load would be domestic hot water, which is estimated to be fairly low for both domestic and non-domestic areas.

5.39 It has been advised by the appointed M&E engineer that the proposed development would not fully utilise the energy generated by CHP engine and therefore would result in inefficient running of the system.

5.40 It is therefore not recommended that gas fired-CHP be considered for this site.

| Bio-fuels | Not Suitable |
|---|---|

5.41 Bio-fuels have the potential to contribute to the reduction of $CO_2$ emissions of various developments by using this fuel within a boiler or CHP plant. Biofuels are considered to have low or zero $CO_2$ intensities as theoretically the $CO_2$ released when these fuels are combusted is no greater than the $CO_2$ that has been absorbed from the atmosphere when the plants grew.

5.42 However, there are a number of issues which must be considered with this type of fuel in urban locations:

- Potential air quality impacts with combusting bio-fuels in urban areas, in particular elevated NOx emissions and particulates and must be addressed.
- Transporting this type of fuel increases lorry movements into and out of London, affecting congestion and transport emissions. The relatively rapid degradation of biodiesel would require appropriately sized on-site storage tanks with regular fuel deliveries.
- Importantly, the actual bio-diesel $CO_2$ intensity cannot be guaranteed due to variations in fuel stock supply, demand, the energy input processing the fuel and $CO_2$ emissions due to growing, harvesting and processing the base fuel.
- Biofuel availability is currently uncertain due to unknown future supply and demand. Whilst an increase in demand for larger developments may stimulate the supply

chain, availability could change with variation in demand. Transport is likely to have the most significant impact on the biofuel industry over emerging building demand.

- Socio-economic issues from growing and harvesting feedstock, with potential impacts on food production, particularly for biodiesel that is imported. Solid biofuels have a lesser impact in this area.
- On-site fuel storage requirements requiring additional space, along with regular access to the on-site fuel storage area.
- Increased plant maintenance is generally required, adding to costs and plant down-time.

5.43 Consequently biofuels for combustion within a boiler are not appropriate for the scheme.

| **Wind Turbines** | **Not Suitable** |
|---|---|

5.44 Although a wind turbine could be sized to meet the requirements of this development, there are numerous factors that would discount its suitability in this setting. Typically wind turbines perform poorly in urban environments as surrounding buildings and features dissipate much of the useful energy of the wind before it can be extracted by the turbine. The tower would also require a large amount of free space for the erecting and periodic maintenance of the turbine. This is likely to be an issue with this site.

5.45 Environmental concerns such as noise and shadow flicker are also problematic in populated areas. While modern turbines have low levels of noise generation, even at high rotational speeds, the noise generated may still be an issue for local residents, particularly given the close proximity of the turbine. Given the dense urban setting of this development, shadow flicker is likely to be a problem for the residents of the proposed development. A wind turbine would not be a viable option for this development.

## 6.0 'ZERO CARBON' TARGET

6.1 The March 2016 revision to the GLA guidance on preparing energy statements clarifies energy targets in the context of Government announcements regarding 'zero carbon' policy.

6.2 "*'Zero carbon' homes are homes forming part of major development applications where the residential element of the application achieves at least 35% reduction in regulated carbon dioxide emissions (beyond Part L 2013) on-site. The remaining regulated carbon dioxide emissions, to 100%, are to be off-set through cash in lieu contribution to the relevant borough to be ring fenced to secure delivery of carbon dioxide savings elsewhere*."

6.3 Camden Council has adopted a higher price for their Carbon Offset Fund, which is set as £90 per tonne of $CO_2$ emitted per year over a period of 30 years, i.e. £2,700 per tonne per year.

6.4 The cash contribution to the Carbon Offsetting Fund has been calculated for the proposed residential part of the development based on the results of the energy modelling for the flats. The non-domestic areas are not required to meet the 'zero carbon' target, as explained is Section 2 of this report. Please refer to Table 6.1 below for details of the calculations.

| London Plan Energy Hierarchy – Residential Part | $CO_2$ emissions (tonnes/year) | Regulated $CO_2$ Savings (tonnes/year) | % $CO_2$ emissions reduction over 'Base Case' |
|---|---|---|---|
| **Base Case: Part L 2013 of the Building Regulations Compliant Development – (TER)** | 62.40 | n/a | n/a |
| **Be Lean - energy efficiency measures** | 62.94 | -0.63 | -1.01% |
| **Be Green – renewable energy ASHPs** | 42.55 | 19.22 | 30.80% |
| **Be Green - renewable energy 6.65kWp PV (allocated for domestic areas)** | 39.93 | 21.84 | 35% |
| **Cumulative $CO_2$ savings (tonnes/year)** | 21.84 | | |
| **Annual savings (tonnes/year)** | 62.4 – 21.84 = 40.56 | | |
| **Cumulative savings for off-set payment (tonnes $CO_2$)** | 30 years x 40.56 = 1,216.8 | | |
| **Cash contribution (£)** | £90 x 1216.8 = £109,512 | | |

**Table 6.1: Carbon Offsetting Fund estimated calculations for residential part of the development**

6.5 The on-site ‘zero carbon’ target has not been achieved for the proposed residential part of the development therefore the Client will commit to meet the shortfall off-site by paying towards Camden Council’s carbon offsetting fund. The funds secured by the council will be ring-fenced to deliver carbon emissions savings off site through a variety of projects and will be secured through Section 106 legal agreements.

# 7.0 CONCLUSION

7.1 This report has been developed to detail the energy efficient features of the development and demonstrates how they relate to the relevant planning policy documents including the London Borough of Camden Local Plan Adoption version (June 2017) and the London Plan.

7.2 The energy assessment follows the principles of the London Plan Energy Hierarchy: 'Be Lean', 'Be Clean' and 'Be Green'. The overriding objective in the formulation of the energy strategy for the scheme has been to maximise the viable reductions in total carbon dioxide emissions within the framework of the energy hierarchy.

7.3 The energy strategy of the scheme has considered measures to adapt and mitigate effects of climate change leading to significant $CO_2$ emission reductions, in particular through an optimised design minimising risk of overheating, the specification of energy efficiency systems and the use of LZC technologies.

7.4 A highly optimised energy strategy based on passive design, building fabric performance and building services systems and controls, and suitable Low and Zero Carbon systems will allow the scheme to achieve an **improvement over Part L 2013 of approximately 21.9%.** The London Plan $CO_2$ emissions reduction requirement (35% Improvement over Part L 2013) is not considered achievable for the scheme due to the practical constraints of the site (limited roof area available for PV).

7.5 The proposed LZC technologies for the scheme (ASHP and array of Photovoltaics (PV) modules) achieve **21.9% $CO_2$ emissions reduction**, which exceed the requirements of the London Plan – Policy 5.7: 'Renewable Energy' and Camden Local Plan Policy CC1: 'Climate change mitigation'.

7.6 The 'zero carbon' target introduced by the Mayor for domestic schemes will be met through financial contribution towards the Carbon Offsetting Fund.

## 8.0 DISCLAIMER

8.1 This report details information gathered from consultation with the design team and Four Quarters (Ingestre Road) Ltd. All information provided has been accepted in good faith as being accurate and representative of the proposed scheme at the time of review.

8.2 Create Consulting Engineers disclaims any responsibility to the Client and others in respect of any matters outside the scope of this report.

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# APPENDICES

# APPENDIX A

# 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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 1 01 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.40 | (1a) | x | 2.50 | (2a) | = | 186.00 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.40 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 186.00 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.36 | (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) = | 0.28 | (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 | 0.36 | 0.35 | 0.34 | 0.31 | 0.30 | 0.27 | 0.27 | 0.26 | 0.28 | 0.30 | 0.32 | 0.33 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.56 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.55 | (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 | | | 30.15 | x | 1.24 | = | 37.26 | | | (27) |
| External wall | | | 37.21 | x | 0.18 | = | 6.70 | | | (29a) |
| Party wall | | | 47.00 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 67.36 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 43.96 | (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 | | 16.87 | (36) |
| Total fabric heat loss | (33) + (36) = | 60.83 | (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) | 34.60 | 34.45 | 34.30 | 33.60 | 33.47 | 32.86 | 32.86 | 32.75 | 33.10 | 33.47 | 33.74 | 34.01 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 95.43 | 95.28 | 95.13 | 94.43 | 94.30 | 93.69 | 93.69 | 93.58 | 93.92 | 94.30 | 94.56 | 94.84 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 94.43 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.28 | 1.28 | 1.28 | 1.27 | 1.27 | 1.26 | 1.26 | 1.26 | 1.26 | 1.27 | 1.27 | 1.27 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.27 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | [illegible] | [illegible] | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.35 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.97 | (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) | 98.96 | 95.36 | 91.77 | 88.17 | 84.57 | [illegible] | 80.97 | 84.57 | 88.17 | 91.77 | 95.36 | 98.96 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1079.59 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.76 | 128.36 | 132.45 | [illegible] | 110.80 | 95.61 | 88.60 | 101.67 | 102.88 | 119.90 | 130.88 | 142.13 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1415.52 | (45) |
| Distribution loss 0.15 x (45)m | 22.01 | 19.25 | 19.87 | 17.32 | 16.62 | 14.34 | 13.29 | 15.25 | 15.43 | 17.99 | 19.63 | 21.32 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 | (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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 |

∑(64)1...12 = 1732.81 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.36 | 62.15 | 65.60 | 59.26 | 58.40 | 52.65 | 51.02 | 55.36 | 55.07 | 61.43 | 64.38 | 68.82 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.48 | 16.42 | 13.35 | 10.11 | 7.56 | 6.38 | 6.89 | 8.96 | 12.03 | 15.27 | 17.82 | 19.00 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 207.34 | 209.49 | 204.07 | 192.53 | 177.96 | 164.26 | 155.12 | [illegible] | 158.39 | 169.93 | 184.50 | 198.19 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | [illegible] | [illegible] | 34.74 | 34.74 | 34.74 | 34.74 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | [illegible] | [illegible] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | [illegible] | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | (71) |
| Water heating gains (Table 5) | 94.56 | 92.49 | 88.17 | [illegible] | 78.49 | [illegible] | 68.57 | 74.41 | 76.49 | 82.56 | 89.42 | 92.49 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 378.61 | 376.62 | 363.81 | [illegible] | 322.23 | 302.00 | 288.80 | 294.56 | 305.12 | 325.98 | 349.96 | 367.91 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.68 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 214.36 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |
| NorthWest | 0.77 | x | 10.00 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 39.41 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 298.36 | 521.30 | 748.04 | 985.13 | 1156.62 | 1171.66 | 1119.87 | 988.35 | 829.58 | 585.52 | 359.75 | 253.79 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 676.97 | 897.92 | 1111.85 | 1328.29 | 1478.85 | 1473.65 | 1408.67 | 1282.91 | 1134.70 | 911.50 | 709.71 | 621.70 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.90 | 0.76 | 0.57 | 0.40 | 0.29 | 0.33 | 0.55 | 0.85 | 0.97 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.86 | 20.17 | 20.53 | 20.83 | 20.96 | 20.99 | 21.00 | 21.00 | 20.97 | 20.75 | 20.23 | 19.79 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.85 | 19.86 | 19.86 | 19.87 | 19.87 | 19.87 | 19.87 | 19.87 | 19.87 | 19.87 | 19.86 | 19.86 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.95 | 0.87 | 0.71 | 0.51 | 0.33 | 0.22 | 0.25 | 0.47 | 0.81 | 0.96 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.38 | 18.83 | 19.31 | 19.69 | 19.83 | 19.87 | 19.87 | 19.87 | 19.85 | 19.61 | 18.92 | 18.29 | (90) |

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.91 | 19.31 | 19.75 | 20.10 | 20.23 | 20.27 | 20.27 | 20.27 | 20.25 | 20.02 | 19.38 | 18.82 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.91 | 19.31 | 19.75 | 20.10 | 20.23 | 20.27 | 20.27 | 20.27 | 20.25 | 20.02 | 19.38 | 18.82 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | | | | | | | | | | | | | |
| | 0.98 | 0.95 | 0.87 | 0.72 | 0.53 | 0.36 | 0.24 | 0.28 | 0.50 | 0.81 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | | |
| | 664.27 | 849.67 | 966.64 | 954.19 | 782.38 | 528.24 | 343[illegible] | 361.75 | 565.40 | 740.29 | 679.82 | 613.26 | (95) |
| Monthly average external temperature from Table U1 | | | | | | | | | | | | | |
| | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | [illegible].60 | [illegible].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] | | | | | | | | | | | | | |
| | 1393.82 | 1372.61 | 1260.12 | 1057.32 | 804.72 | [illegible]13 | [illegible]44.13 | [illegible]2.45 | 577.83 | 887.98 | 1161.56 | 1386.91 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x [illegible]m | | | | | | | | | | | | | |
| | 542.79 | 351.42 | 218.35 | 74.25 | 16.62 | 0.00 | 0.00 | 0.00 | 0.00 | 109.88 | 346.86 | 575.59 | |

∑(98)1...5, 10...12 = 2235.75 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 30.05 (99)

## 9b. Energy requirements - community heating [illegible]

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplemen[illegible]y syst[illegible] (ta[illegible]1) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 2235.75 | | | (98) |
| Space heat from heat pump | | (98) x (304a) x (305) x (306) = | 2347.54 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1732.81 | | | (64) |
| Water heat from heat pump | | (64) x (303a) x (305a) x (306) = | 1819.45 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 41.67 | (313) |

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

| | | | | | | |
|---|---|---|---|---|---|---|
| Total electricity for the above, kWh/year | | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | | 326.44 | (332) |
| Total delivered energy for all uses | | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4493.43 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 2347.54 | x | 4.24 | x 0.01 = | 99.54 | (340a) |
| Water heating from heat pump | 1819.45 | x | 4.24 | x 0.01 = | 77.14 | (342a) |
| Electricity for lighting | 326.44 | x | 13.19 | x 0.01 = | 43.06 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 339.74 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.20 | (357) |
| SAP value | 83.33 | |
| 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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1190.57 | x | 0.519 | = | 617.91 | (367) |
| Electrical energy for community heat distribution | 41.67 | x | 0.519 | = | 21.63 | (372) |
| Total CO2 associated with community systems | | | | | 639.53 | (373) |
| Total CO2 associated with space and water heating | | | | | 639.53 | (376) |
| Electricity for lighting | 326.44 | x | 0.519 | = | 169.42 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 808.96 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 10.87 | (384) |
| EI value | | | | | 90.92 | |
| EI rating (section 14) | | | | | 91 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1190.57 | x | 3.07 | = | 3655.05 | (367) |
| Electrical energy for community heat distribution | 41.67 | x | 3.07 | = | 127.93 | (372) |
| Total primary energy associated with community systems | | | | | 3782.97 | (373) |
| Total primary energy associated with space and water heating | | | | | 3782.97 | (376) |
| Electricity for lighting | 326.44 | x | 3.07 | = | 1002.18 | (379) |
| Primary energy kWh/year | | | | | 4785.16 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 64.32 | (384) |

# DER Worksheet
# Design - Draft

NHER

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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 1 02 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 76.52 | (1a) | x | 2.50 | (2a) | = | 191.30 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 76.52 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 191.30 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.36 | (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) = | 0.28 | (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 | 0.35 | 0.35 | 0.34 | 0.30 | 0.30 | 0.26 | 0.26 | 0.26 | 0.28 | 0.30 | 0.31 | 0.32 | (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 | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (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 | | | 19.92 | x | 1.24 | = | 24.62 | | | (27) |
| External wall | | | 12.70 | x | 0.18 | = | 2.29 | | | (29a) |
| Party wall | | | 64.09 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 32.62 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 26.90 | (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 | | 10.94 | (36) |
| Total fabric heat loss | (33) + (36) = | 37.84 | (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) | 35.49 | 35.34 | 35.19 | 34.49 | 34.35 | 33.74 | 33.74 | 33.63 | 33.98 | 34.35 | 34.62 | 34.90 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 73.33 | 73.18 | 73.03 | 72.33 | 72.20 | 71.59 | 71.59 | 71.47 | 71.82 | 72.20 | 72.46 | 72.74 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 72.33 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.96 | 0.96 | 0.95 | 0.95 | 0.94 | 0.94 | 0.94 | 0.93 | 0.94 | 0.94 | 0.95 | 0.95 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.95 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 3[illegible] | 3[illegible] | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.39 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 91.05 | (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) | 100.15 | 96.51 | 92.87 | 89.23 | 85.58 | 8[illegible]4 | 81.94 | 85.58 | 89.23 | 92.87 | 96.51 | 100.15 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1092.55 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 148.52 | 129.90 | 134.04 | 1[illegible]86 | 112.13 | 96.76 | 89.66 | 102.89 | 104.12 | 121.34 | 132.45 | 143.83 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1432.51 | (45) |
| Distribution loss 0.15 x (45)m | 22.28 | 19.48 | 20.11 | 17.53 | 16.82 | 14.51 | 13.45 | 15.43 | 15.62 | 18.20 | 19.87 | 21.58 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 |

∑(64)1...12 = 1749.80 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.94 | 62.66 | 66.13 | 59.72 | 58.84 | 53.04 | 51.37 | 55.77 | 55.48 | 61.90 | 64.90 | 69.38 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.90 | 16.79 | 13.65 | 10.34 | 7.73 | 6.52 | 7.05 | 9.16 | 12.30 | 15.61 | 18.22 | 19.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 212.01 | 214.21 | 208.67 | 196.87 | 181.97 | 167.97 | 158.61 | [illegible] | 161.96 | 173.76 | 188.66 | 202.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | [illegible] | [illegible] | 34.97 | 34.97 | 34.97 | 34.97 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | [illegible] | [illegible] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | [illegible] | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | (71) |
| Water heating gains (Table 5) | 95.35 | 93.25 | 88.88 | [illegible] | 79.09 | [illegible] | 69.05 | 74.96 | 77.06 | 83.20 | 90.14 | 93.26 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 385.17 | 383.15 | 370.11 | [illegible] | 327.69 | 307.05 | 293.61 | 299.43 | 310.21 | 331.48 | 355.93 | 374.25 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.45 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 211.40 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 255.99 | 436.05 | 596.62 | 739.25 | 828.02 | 822.03 | 792.52 | 726.30 | 646.02 | 481.93 | 306.62 | 219.08 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 641.16 | 819.20 | 966.73 | 1088.30 | 1155.70 | 1129.08 | 1086.13 | 1025.73 | 956.23 | 813.41 | 662.55 | 593.32 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 0.99 | 0.96 | 0.89 | 0.75 | 0.57 | 0.40 | 0.29 | 0.32 | 0.51 | 0.82 | 0.97 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.25 | 20.50 | 20.75 | 20.92 | 20.99 | 21.00 | 21.00 | 21.00 | 20.99 | 20.89 | 20.53 | 20.19 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.12 | 20.12 | 20.12 | 20.13 | 20.13 | 20.14 | 20.14 | 20.14 | 20.13 | 20.13 | 20.13 | 20.12 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.95 | 0.87 | 0.71 | 0.52 | 0.35 | 0.23 | 0.26 | 0.45 | 0.78 | 0.96 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.13 | 19.49 | 19.83 | 20.05 | 20.12 | 20.14 | 20.14 | 20.14 | 20.13 | 20.02 | 19.55 | 19.06 | (90) |

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.52 | 19.84 | 20.15 | 20.35 | 20.42 | 20.44 | 20.44 | 20.44 | 20.43 | 20.32 | 19.89 | 19.45 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.52 | 19.84 | 20.15 | 20.35 | 20.42 | 20.44 | 20.44 | 20.44 | 20.43 | 20.32 | 19.89 | 19.45 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.98 | 0.95 | 0.87 | 0.72 | 0.54 | 0.37 | 0.25 | 0.28 | 0.47 | 0.79 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 630.15 | 775.06 | 837.88 | 781.70 | 621.46 | 417.03 | 274.59 | 288.4[illegible] | 451.73 | 638.96 | 633.53 | 586.22 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16[illegible]0 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1116.21 | 1093.60 | 996.63 | 828.37 | 629.50 | 417.74 | 27[illegible] | 288.[illegible] | 454.64 | 702.09 | 927.03 | 1109.54 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 361.63 | 214.06 | 118.11 | 33.60 | 5.[illegible] | 0.00 | 0.00 | 0.00 | 0.00 | 46.97 | 211.32 | 389.35 | |

∑(98)1...5, 10...12 = 1381.02 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 18.05 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 1381.02 | | | (98) |
| Space heat from heat pump | | (98) x (304a) x (305) x (306) = | 1450.07 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1749.80 | | | (64) |
| Water heat from heat pump | | (64) x (303a) x (305a) x (306) = | 1837.29 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 32.87 | (313) |

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

| | | | |
|---|---|---|---|
| Total electricity for the above, kWh/year | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | 333.80 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 3621.17 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 1450.07 | x | 4.24 | x 0.01 = | 61.48 | (340a) |
| Water heating from heat pump | 1837.29 | x | 4.24 | x 0.01 = | 77.90 | (342a) |
| Electricity for lighting | 333.80 | x | 13.19 | x 0.01 = | 44.03 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 303.41 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.05 | (357) |
| SAP value | 85.37 | |
| 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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 93[illegible]5 | x | 0.519 | = | 487.47 | (367) |
| Electrical energy for community heat distribution | 32.87 | x | 0.519 | = | 17.06 | (372) |
| Total CO2 associated with community systems | | | | | 504.53 | (373) |
| Total CO2 associated with space and water heating | | | | | 504.53 | (376) |
| Electricity for lighting | 333.80 | x | 0.519 | = | 173.24 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 677.77 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 8.86 | (384) |
| EI value | | | | | 92.53 | |
| EI rating (section 14) | | | | | 93 | (385) |
| EI band | | | | | A | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 939.25 | x | 3.07 | = | 2883.49 | (367) |
| Electrical energy for community heat distribution | 32.87 | x | 3.07 | = | 100.92 | (372) |
| Total primary energy associated with community systems | | | | | 2984.41 | (373) |
| Total primary energy associated with space and water heating | | | | | 2984.41 | (376) |
| Electricity for lighting | 333.80 | x | 3.07 | = | 1024.77 | (379) |
| Primary energy kWh/year | | | | | 4009.18 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 52.39 | (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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 2 05 above hobby room Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 88.78 | (1a) | x | 2.50 | (2a) | = | 221.95 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 88.78 | (4) | | | | | | |
| Dwelling volume | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | 221.95 | (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) = | 0.14 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.34 | (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) = | 0.26 | (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 | 0.33 | 0.32 | 0.32 | 0.29 | 0.28 | 0.25 | 0.25 | 0.24 | 0.26 | 0.28 | 0.29 | 0.31 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (24d) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (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 | | | 23.79 | x | 1.24 | = | 29.40 | | | (27) |
| Exposed floor | | | 88.78 | x | 0.06 | = | 5.33 | | | (28b |
| External wall | | | 28.81 | x | 0.18 | = | 5.19 | | | (29a) |
| Party wall | | | 32.04 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 16.11 | x | 0.12 | = | 1.93 | | | (30) |
| Total area of external elements ∑A, m² | | | 157.49 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 41.84 | (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 | | 15.04 | (36) |
| Total fabric heat loss | (33) + (36) = | 56.88 | (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) | 40.64 | 40.48 | 40.33 | 39.61 | 39.48 | 38.85 | 38.85 | 38.74 | 39.09 | 39.48 | 39.75 | 40.03 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 97.52 | 97.37 | 97.21 | 96.49 | 96.36 | 95.73 | 95.73 | [illegible] | 95.98 | 96.36 | 96.63 | 96.92 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 96.49 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.10 | 1.10 | 1.09 | 1.09 | 1.09 | 1.08 | 1.08 | 1.08 | 1.08 | 1.09 | 1.09 | 1.09 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.09 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.61 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 96.16 | (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) | 105.77 | 101.92 | 98.08 | 94.23 | 90.39 | 86.54 | 86.54 | 90.39 | 94.23 | 98.08 | 101.92 | 105.77 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1153.87 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x ΔTm/3600 kWh/month (see Tables 1b, 1c 1d) | 156.86 | 137.19 | 141.56 | 123.42 | 118.42 | 102.19 | 94.69 | 108.66 | 109.96 | 128.15 | 139.88 | 151.91 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1512.90 | (45) |
| Distribution loss 0.15 x (45)m | 23.53 | 20.58 | 21.23 | 18.51 | 17.76 | 15.33 | 14.20 | 16.30 | 16.49 | 19.22 | 20.98 | 22.79 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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 | 183.80 | 161.53 | 168.51 | 149.50 | 145.37 | 128.27 | 121.64 | 135.61 | 136.04 | 155.10 | 165.96 | 178.85 | (62) |
| Solar DHW input calculated using Appendix G or Appendix H | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (63) |
| Output from water heater for each month (kWh/month) (62)m + (63)m | 183.80 | 161.53 | 168.51 | 149.50 | 145.37 | 128.27 | 121.64 | 135.61 | 136.04 | 155.10 | 165.96 | 178.85 | |

∑(64)1...12 = 1830.19 (64)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m] | 73.71 | 65.09 | 68.63 | 61.90 | 60.93 | 54.84 | 53.04 | 57.69 | 57.43 | 64.17 | 67.37 | 72.07 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.4[illegible] | 130.43 | 130.43 | 130.43 | 130.43 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 21.11 | 18.75 | 15.25 | 11.55 | 8.63 | 7.29 | 7.87 | 10[illegible] | 13.74 | 17.44 | 20.35 | 21.70 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 236.82 | 239.27 | 233.08 | 219.90 | 203.26 | 187.61 | 17[illegible] | 174.[illegible] | 180.90 | 194.08 | 210.73 | 226.37 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 36.04 | 36.04 | 36.04 | 36.04 | 36.[illegible] | 36.0[illegible] | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.0[illegible] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -104.35 | -104.35 | -104.35 | [illegible]4.35 | -104.35 | -1[illegible].35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | (71) |
| Water heating gains (Table 5) | 99.08 | 96.86 | 92.24 | [illegible]5.97 | 81.9[illegible] | 76.17 | 71.30 | 77.54 | 79.76 | 86.25 | 93.58 | 96.86 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 419.13 | 417.01 | 402.70 | 379[illegible]4 | 355.92 | 333.20 | 318.46 | 324.61 | 336.52 | 359.90 | 386.79 | 407.06 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthEast | 0.77 | x | 16.66 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 214.10 | (77) |
| NorthWest | 0.77 | x | 7.13 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 28.10 | (81) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | 242.20 | 421.88 | 602.03 | 787.50 | 919.99 | 930.02 | 889.69 | 788.30 | 665.86 | 472.96 | 291.80 | 206.17 | (83) |
| Total gains - internal and solar (73)m + (83)m | 661.33 | 838.89 | 1004.73 | 1167.04 | 1275.90 | 1263.22 | 1208.16 | 1112.91 | 1002.38 | 832.86 | 678.58 | 613.23 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.94 | 0.84 | 0.67 | 0.48 | 0.35 | 0.39 | 0.63 | 0.91 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.96 | 20.21 | 20.51 | 20.80 | 20.95 | 20.99 | 21.00 | 21.00 | 20.97 | 20.74 | 20.28 | 19.91 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.00 | 20.00 | 20.00 | 20.01 | 20.01 | 20.02 | 20.02 | 20.02 | 20.02 | 20.01 | 20.01 | 20.01 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.93 | 0.80 | 0.61 | 0.41 | 0.27 | 0.31 | 0.55 | 0.87 | 0.98 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.63 | 18.98 | 19.41 | 19.80 | 19.97 | 20.01 | 20.02 | 20.02 | 20.00 | 19.73 | 19.10 | 18.56 | (90) |

Living area fraction — Living area ÷ (4) = 0.44 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.22 | 19.52 | 19.89 | 20.24 | 20.40 | 20.44 | 20.45 | 20.45 | 20.43 | 20.17 | 19.62 | 19.16 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.22 | 19.52 | 19.89 | 20.24 | 20.40 | 20.44 | 20.45 | 20.45 | 20.43 | 20.17 | 19.62 | 19.16 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.97 | 0.93 | 0.81 | 0.63 | 0.44 | 0.30 | 0.35 | 0.59 | 0.88 | 0.98 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 655.38 | 816.28 | 930.85 | 947.62 | 804.50 | 555.33 | 368.07 | [illegible] | 589.38 | 732.97 | 663.89 | 609.32 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | [illegible] | [illegible] | 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] | 1454.91 | 1423.63 | 1301.98 | 1094.21 | [illegible] | [illegible] | 368.55 | 387.22 | 607.07 | 922.52 | 1209.63 | 1449.60 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 594.85 | 408.14 | 276.12 | 105.54 | 25.27 | [illegible] | 0.00 | 0.00 | 0.00 | 141.03 | 392.93 | 625.17 | (98) |

∑(98)1...5, 10...12 = 2569.05 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 28.94 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 2569.05 | | | (98) |
| Space heat from heat pump | | (98) x (304a) x (305) x (306) = | 2697.51 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1830.19 | | | (64) |
| Water heat from heat pump | | (64) x (303a) x (305a) x (306) = | 1921.70 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 46.19 | (313) |

| | | |
|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | |
| Total electricity for the above, kWh/year | 0.00 | (331) |
| Electricity for lighting (Appendix L) | 372.85 | (332) |
| Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4992.06 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 2697.51 | x | 4.24 | x 0.01 = | 114.37 | (340a) |
| Water heating from heat pump | 1921.70 | x | 4.24 | x 0.01 = | 81.48 | (342a) |
| Electricity for lighting | 372.85 | x | 13.19 | x 0.01 = | 49.18 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 365.03 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.15 | (357) |
| SAP value | 84.01 | |
| 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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1319.77 | x | 0.519 | = | 684.96 | (367) |
| Electrical energy for community heat distribution | 46.19 | x | 0.519 | = | 23.97 | (372) |
| Total CO2 associated with community systems | | | | | 708.94 | (373) |
| Total CO2 associated with space and water heating | | | | | 708.94 | (376) |
| Electricity for lighting | 372.85 | x | 0.519 | = | 193.51 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 902.45 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 10.16 | (384) |
| EI value | | | | | 90.96 | |
| EI rating (section 14) | | | | | 91 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1319.77 | x | 3.07 | = | 4051.71 | (367) |
| Electrical energy for community heat distribution | 46.19 | x | 3.07 | = | 141.81 | (372) |
| Total primary energy associated with community systems | | | | | 4193.52 | (373) |
| Total primary energy associated with space and water heating | | | | | 4193.52 | (376) |
| Electricity for lighting | 372.85 | x | 3.07 | = | 1144.65 | (379) |
| Primary energy kWh/year | | | | | 5338.16 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 60.13 | (384) |

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
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## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.40 | (1a) | x | 2.50 | (2a) | = | 186.00 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.40 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 186.00 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.36 | (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) = | 0.28 | (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 | 0.36 | 0.35 | 0.34 | 0.31 | 0.30 | 0.27 | 0.27 | 0.26 | 0.28 | 0.30 | 0.32 | 0.33 | (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 | 0.56 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.55 | (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 | | | 30.15 | x | 1.24 | = | 37.26 | | | (27) |
| External wall | | | 37.21 | x | 0.18 | = | 6.70 | | | (29a) |
| Party wall | | | 47.00 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 24.36 | x | 0.12 | = | 2.92 | | | (30) |
| Total area of external elements ∑A, m² | | | 91.72 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 46.88 | (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 | | 15.59 | (36) |
| Total fabric heat loss | (33) + (36) = | 62.47 | (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) | 34.60 | 34.45 | 34.30 | 33.60 | 33.47 | 32.86 | 32.86 | 32.75 | 33.10 | 33.47 | 33.74 | 34.01 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 97.07 | 96.92 | 96.77 | 96.07 | 95.94 | 95.33 | 95.33 | 95.21 | 95.56 | 95.94 | 96.20 | 96.48 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 96.07 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.30 | 1.30 | 1.30 | 1.29 | 1.29 | 1.28 | 1.2[illegible] | 1.28 | 1.28 | 1.29 | 1.29 | 1.30 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.29 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 3[illegible].00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.35 | (42) |
| Annual average hot water usage in litres per day Vd,average (25 x N) + 36 | 89.97 | (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) | 98.96 | 95.36 | 91.77 | 88.17 | 84.57 | 80.97 | 80.97 | 84.57 | 88.17 | 91.77 | 95.36 | 98.96 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1079.59 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x ΔTm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.76 | 128.36 | 132.45 | 115.[illegible]7 | 110.80 | 95.61 | 88.60 | 101.67 | 102.88 | 119.90 | 130.88 | 142.13 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1415.52 | (45) |
| Distribution loss 0.15 x (45)m | 22.01 | 19.25 | 19.87 | 17.32 | 16.62 | 14.34 | 13.29 | 15.25 | 15.43 | 17.99 | 19.63 | 21.32 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 | (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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 |

∑(64)1...12 = 1732.81 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.36 | 62.15 | 65.60 | 59.26 | 58.40 | 52.65 | 51.02 | 55.36 | 55.07 | 61.43 | 64.38 | 68.82 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | | | | | | | | | | | | | |
| | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 18.48 | 16.42 | 13.35 | 10.11 | 7.56 | 6.38 | [illegible] | 8.96 | 12.03 | 15.27 | 17.82 | 19.00 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 207.34 | 209.49 | 204.07 | 192.53 | 177.96 | 164.26 | [illegible] | [illegible] | 158.39 | 169.93 | 184.50 | 198.19 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | (69) |
| Pump and fan gains (Table 5a) | | | | | | | | | | | | | |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | | | | | | | | | | | | | |
| | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 94.56 | 92.49 | 88.17 | 82.30 | 78.49 | 73.13 | 68.57 | 74.41 | 76.49 | 82.56 | 89.42 | 92.49 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | | | | | | | | | | | | | |
| | 378.61 | 376.62 | 363.81 | [illegible] | 322.23 | 302.00 | 288.80 | 294.56 | 305.12 | 325.98 | 349.96 | 367.91 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.68 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 214.36 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |
| NorthWest | 0.77 | x | 10.00 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 39.41 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 298.36 | 521.30 | 748.04 | 985.13 | 1156.62 | 1171.66 | 1119.87 | 988.35 | 829.58 | 585.52 | 359.75 | 253.79 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 676.97 | 897.92 | 1111.85 | 1328.29 | 1478.85 | 1473.65 | 1408.67 | 1282.91 | 1134.70 | 911.50 | 709.71 | 621.70 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.90 | 0.76 | 0.58 | 0.41 | 0.30 | 0.34 | 0.56 | 0.86 | 0.97 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.83 | 20.15 | 20.51 | 20.82 | 20.95 | 20.99 | 21.00 | 21.00 | 20.97 | 20.73 | 20.20 | 19.77 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.84 | 19.84 | 19.84 | 19.85 | 19.85 | 19.86 | 19.86 | 19.86 | 19.85 | 19.85 | 19.85 | 19.84 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.95 | 0.88 | 0.71 | 0.51 | 0.34 | 0.22 | 0.26 | 0.48 | 0.81 | 0.96 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.32 | 18.77 | 19.27 | 19.66 | 19.81 | 19.85 | 19.86 | 19.86 | 19.83 | 19.58 | 18.87 | 18.23 | (90) |

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.86 | 19.26 | 19.71 | 20.07 | 20.22 | 20.26 | 20.26 | 20.26 | 20.24 | 19.99 | 19.34 | 18.78 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.86 | 19.26 | 19.71 | 20.07 | 20.22 | 20.26 | 20.26 | 20.26 | 20.24 | 19.99 | 19.34 | 18.78 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.98 | 0.95 | 0.87 | 0.72 | 0.54 | 0.36 | 0.25 | 0.29 | 0.50 | 0.82 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 664.36 | 850.48 | 969.79 | 961.89 | 792.31 | 535.96 | 348.65 | [illegible] | 572.68 | 744.02 | 680.26 | 613.29 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | [illegible] | [illegible] | 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] | 1413.37 | 1391.96 | 1278.21 | 1073.28 | [illegible] | [illegible] | 349.07 | 367.71 | 586.61 | 900.84 | 1177.92 | 1406.50 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 557.26 | 363.88 | 229.47 | 80.20 | 18.55 | [illegible] | 0.00 | 0.00 | 0.00 | 116.68 | 358.31 | 590.14 | |

∑(98)1...5, 10...12 = 2314.49 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 31.11 (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 heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 2314.49 | | (98) |
| Space heat from heat pump | (98) x (304a) x (305) x (306) = | 2430.22 | (307a) |

**Water heating**

| | | | |
|---|---|---|---|
| Annual water heating requirement | 1732.81 | | (64) |
| Water heat from heat pump | (64) x (303a) x (305a) x (306) = | 1819.45 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 42.50 | (313) |

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

| | | | |
|---|---|---|---|
| Total electricity for the above, kWh/year | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | 326.44 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4576.11 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 2430.22 | x | 4.24 | x 0.01 = | 103.04 | (340a) |
| Water heating from heat pump | 1819.45 | x | 4.24 | x 0.01 = | 77.14 | (342a) |
| Electricity for lighting | 326.44 | x | 13.19 | x 0.01 = | 43.06 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 343.24 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.21 | (357) |
| SAP value | 83.16 | |
| 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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1214.19 | x | 0.519 | = | 630.16 | (367) |
| Electrical energy for community heat distribution | [illegible] | x | 0.519 | = | 22.06 | (372) |
| Total CO2 associated with community systems | | | | | 652.22 | (373) |
| Total CO2 associated with space and water heating | | | | | 652.22 | (376) |
| Electricity for lighting | 326.44 | x | 0.519 | = | 169.42 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 821.65 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 11.04 | (384) |
| EI value | | | | | 90.78 | |
| EI rating (section 14) | | | | | 91 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1214.19 | x | 3.07 | = | 3727.56 | (367) |
| Electrical energy for community heat distribution | 42.50 | x | 3.07 | = | 130.46 | (372) |
| Total primary energy associated with community systems | | | | | 3858.03 | (373) |
| Total primary energy associated with space and water heating | | | | | 3858.03 | (376) |
| Electricity for lighting | 326.44 | x | 3.07 | = | 1002.18 | (379) |
| Primary energy kWh/year | | | | | 4860.21 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 65.33 | (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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
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## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 76.52 | (1a) | x | 2.50 | (2a) | = | 191.30 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 76.52 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 191.30 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.36 | (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) = | 0.28 | (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 | 0.35 | 0.35 | 0.34 | 0.30 | 0.30 | 0.26 | 0.26 | 0.26 | 0.28 | 0.30 | 0.31 | 0.32 | (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 | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (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 | | | 19.92 | x | 1.24 | = | 24.62 | | | (27) |
| External wall | | | 12.70 | x | 0.18 | = | 2.29 | | | (29a) |
| Party wall | | | 64.09 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 9.65 | x | 0.12 | = | 1.16 | | | (30) |
| Total area of external elements ∑A, m² | | | 42.27 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 28.06 | (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 | | 10.11 | (36) |
| Total fabric heat loss | (33) + (36) = | 38.17 | (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) | 35.49 | 35.34 | 35.19 | 34.49 | 34.35 | 33.74 | 33.74 | 33.63 | 33.98 | 34.35 | 34.62 | 34.90 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 73.66 | 73.50 | 73.35 | 72.65 | 72.52 | 71.91 | 71.91 | 71.80 | 72.15 | 72.52 | 72.79 | 73.06 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 72.65 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.96 | 0.96 | 0.96 | 0.95 | 0.95 | 0.94 | [illegible] | 0.94 | 0.94 | 0.95 | 0.95 | 0.95 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.95 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | [illegible] | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.39 | (42) |
| Annual average hot water usage in litres per day Vd,average [illegible] (25 x N) [illegible] | 91.05 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month [illegible] m = factor from Table 1[illegible] (43) | 100.15 | 96.51 | 92.87 | 89.23 | 85.58 | 81.94 | 81.94 | 85.58 | 89.23 | 92.87 | 96.51 | 100.15 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1092.55 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm [illegible] m/3600 kWh/month (see Tables 1b, 1c 1d) | 148.52 | 129.90 | 134.04 | [illegible] | 112.13 | 96.76 | 89.66 | 102.89 | 104.12 | 121.34 | 132.45 | 143.83 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1432.51 | (45) |
| Distribution loss 0.15 x (45)m | 22.28 | 19.48 | 20.11 | 17.53 | 16.82 | 14.51 | 13.45 | 15.43 | 15.62 | 18.20 | 19.87 | 21.58 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 | |

∑(64)1...12 = 1749.80 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.94 | 62.66 | 66.13 | 59.72 | 58.84 | 53.04 | 51.37 | 55.77 | 55.48 | 61.90 | 64.90 | 69.38 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.90 | 16.79 | 13.65 | 10.34 | 7.73 | 6.52 | [illegible] | 9.16 | 12.30 | 15.61 | 18.22 | 19.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 212.01 | 214.21 | 208.67 | 196.87 | 181.97 | 167.97 | [illegible] | [illegible] | 161.96 | 173.76 | 188.66 | 202.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | (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) | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | (71) |
| Water heating gains (Table 5) | 95.35 | 93.25 | 88.88 | 82.94 | 79.09 | 73.66 | 69.05 | 74.96 | 77.06 | 83.20 | 90.14 | 93.26 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 385.17 | 383.15 | 370.11 | [illegible] | 327.69 | 307.05 | 293.61 | 299.43 | 310.21 | 331.48 | 355.93 | 374.25 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.45 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 211.40 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 255.99 | 436.05 | 596.62 | 739.25 | 828.02 | 822.03 | 792.52 | 726.30 | 646.02 | 481.93 | 306.62 | 219.08 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 641.16 | 819.20 | 966.73 | 1088.30 | 1155.70 | 1129.08 | 1086.13 | 1025.73 | 956.23 | 813.41 | 662.55 | 593.32 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.89 | 0.75 | 0.57 | 0.41 | 0.29 | 0.32 | 0.52 | 0.82 | 0.97 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.24 | 20.50 | 20.74 | 20.92 | 20.98 | 21.00 | 21.00 | 21.00 | 20.99 | 20.89 | 20.53 | 20.19 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.11 | 20.12 | 20.12 | 20.13 | 20.13 | 20.13 | 20.13 | 20.14 | 20.13 | 20.13 | 20.12 | 20.12 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.95 | 0.87 | 0.71 | 0.52 | 0.35 | 0.23 | 0.26 | 0.45 | 0.78 | 0.96 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.12 | 19.48 | 19.82 | 20.04 | 20.11 | 20.13 | 20.13 | 20.13 | 20.13 | 20.02 | 19.54 | 19.05 | (90) |

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.51 | 19.83 | 20.14 | 20.35 | 20.42 | 20.43 | 20.43 | 20.43 | 20.43 | 20.32 | 19.88 | 19.44 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.51 | 19.83 | 20.14 | 20.35 | 20.42 | 20.43 | 20.43 | 20.43 | 20.43 | 20.32 | 19.88 | 19.44 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | | | | | | | | | | | | | |
| | 0.98 | 0.95 | 0.87 | 0.72 | 0.54 | 0.37 | 0.25 | 0.28 | 0.47 | 0.79 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | | |
| | 630.21 | 775.40 | 838.94 | 783.79 | 623.75 | 418.71 | 275[illegible] | 289.58 | 453.47 | 640.29 | 633.74 | 586.26 | (95) |
| Monthly average external temperature from Table U1 | | | | | | | | | | | | | |
| | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | [illegible]60 | [illegible]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] | | | | | | | | | | | | | |
| | 1120.40 | 1097.74 | 1000.49 | 831.74 | 632.10 | 4[illegible]45 | 275.71 | [illegible]9.69 | 456.50 | 704.87 | 930.55 | 1113.74 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x [illegible]m | | | | | | | | | | | | | |
| | 364.70 | 216.61 | 120.19 | 34.52 | 6.21 | 0.00 | [illegible].00 | 0.00 | 0.00 | 48.05 | 213.70 | 392.45 | |

∑(98)1...5, 10...12 = 1396.43 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 18.25 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 1396.43 | | | (98) |
| Space heat from heat pump | | (98) x (304a) x (305) x (306) = | 1466.26 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1749.80 | | | (64) |
| Water heat from heat pump | | (64) x (303a) x (305a) x (306) = | 1837.29 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 33.04 | (313) |

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

| | | | | | | |
|---|---|---|---|---|---|---|
| Total electricity for the above, kWh/year | | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | | 333.80 | (332) |
| Total delivered energy for all uses | | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 3637.35 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 1466.26 | x | 4.24 | x 0.01 = | 62.17 | (340a) |
| Water heating from heat pump | 1837.29 | x | 4.24 | x 0.01 = | 77.90 | (342a) |
| Electricity for lighting | 333.80 | x | 13.19 | x 0.01 = | 44.03 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 304.10 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.05 | (357) |
| SAP value | 85.34 | |
| 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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 943.87 | x | 0.519 | = | 489.87 | (367) |
| Electrical energy for community heat distribution | 33.04 | x | 0.519 | = | 17.15 | (372) |
| Total CO2 associated with community systems | | | | | 507.01 | (373) |
| Total CO2 associated with space and water heating | | | | | 507.01 | (376) |
| Electricity for lighting | 333.80 | x | 0.519 | = | 173.24 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 680.26 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 8.89 | (384) |
| EI value | | | | | 92.50 | |
| EI rating (section 14) | | | | | 92 | (385) |
| EI band | | | | | A | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 943.87 | x | 3.07 | = | 2897.68 | (367) |
| Electrical energy for community heat distribution | 33.04 | x | 3.07 | = | 101.42 | (372) |
| Total primary energy associated with community systems | | | | | 2999.10 | (373) |
| Total primary energy associated with space and water heating | | | | | 2999.10 | (376) |
| Electricity for lighting | 333.80 | x | 3.07 | = | 1024.77 | (379) |
| Primary energy kWh/year | | | | | 4023.87 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 52.59 | (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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 5 01 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 86.50 | (1a) | x | 2.50 | (2a) | = | 216.25 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 86.50 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 216.25 | (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) = | 0.14 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.34 | (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) = | 0.26 | (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 | 0.33 | 0.33 | 0.32 | 0.29 | 0.28 | 0.25 | 0.25 | 0.24 | 0.26 | 0.28 | 0.30 | 0.31 | (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 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (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 | | | 29.06 | x | 1.24 | = | 35.91 | | | (27) |
| External wall | | | 25.62 | x | 0.18 | = | 4.61 | | | (29a) |
| Party wall | | | 54.80 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 86.50 | x | 0.12 | = | 10.38 | | | (30) |
| Total area of external elements ∑A, m² | | | 141.18 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 50.90 | (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 | | 21.37 | (36) |
| Total fabric heat loss | (33) + (36) = | 72.27 | (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) | 39.68 | 39.52 | 39.37 | 38.66 | 38.52 | 37.90 | 37.90 | 37.79 | 38.14 | 38.52 | 38.79 | 39.08 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 111.95 | 111.79 | 111.64 | 110.93 | 110.79 | 110.17 | 110.17 | 110.06 | 110.41 | 110.79 | 111.06 | 111.35 | |

Average = ∑(39)1...12/12 = 110.93 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.29 | 1.29 | 1.29 | 1.28 | 1.28 | 1.27 | 1.27 | 1.27 | 1.28 | 1.28 | 1.28 | 1.29 | |

Average = ∑(40)1...12/12 = 1.28 (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 | 2.57 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 95.35 | (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) | 104.88 | 101.07 | 97.26 | 93.44 | 89.63 | 85.81 | 85.81 | 89.63 | 93.44 | 97.26 | 101.07 | 104.88 | |

∑(44)1...12 = 1144.20 (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 ΔTm/3600 kWh/month (see Tables 1b, 1c 1d) | 155.54 | 136.04 | 140.38 | 122.[illegible]8 | 117.43 | 101.33 | 93.90 | 107.75 | 109.04 | 127.08 | 138.71 | 150.63 | |

∑(45)1...12 = 1500.22 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 23.33 | 20.41 | 21.06 | 18.36 | 17.61 | 15.20 | 14.09 | 16.16 | 16.36 | 19.06 | 20.81 | 22.59 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 182.49 | 160.38 | 167.33 | 148.46 | 144.38 | 127.41 | 120.85 | 134.70 | 135.12 | 154.02 | 164.79 | 177.58 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 182.49 | 160.38 | 167.33 | 148.46 | 144.38 | 127.41 | 120.85 | 134.70 | 135.12 | 154.02 | 164.79 | 177.58 | |

∑(64)1...12 = 1817.51 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 73.28 | 64.70 | 68.23 | 61.56 | 60.60 | 54.56 | 52.78 | 57.39 | 57.12 | 63.81 | 66.99 | 71.64 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | | | | | | | | | | | | | |
| | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 20.73 | 18.41 | 14.97 | 11.33 | 8.47 | 7.15 | [illegible] | 10.05 | 13.48 | 17.12 | 19.98 | 21.30 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 232.49 | 234.90 | 228.82 | 215.88 | 199.54 | 184.19 | [illegible] | [illegible] | 177.60 | 190.54 | 206.88 | 222.23 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | (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) | | | | | | | | | | | | | |
| | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 98.49 | 96.29 | 91.71 | 85.49 | 81.46 | 75.77 | 70.94 | 77.13 | 79.33 | 85.77 | 93.03 | 96.30 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | | | | | | | | | | | | | |
| | 413.33 | 411.22 | 397.13 | [illegible] | 351.09 | 328.73 | 314.22 | 320.32 | 332.03 | 355.05 | 381.51 | 401.45 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 23.26 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 298.92 | (79) |
| NorthWest | 0.77 | x | 5.80 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 22.86 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 321.77 | 555.69 | 780.48 | 1000.86 | 1151.90 | 1157.14 | 1109.96 | 995.20 | 856.48 | 619.59 | 386.79 | 274.48 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 735.10 | 966.91 | 1177.61 | 1375.19 | 1502.99 | 1485.87 | 1424.18 | 1315.52 | 1188.51 | 974.64 | 768.31 | 675.93 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.97 | 0.92 | 0.81 | 0.64 | 0.47 | 0.34 | 0.38 | 0.61 | 0.88 | 0.98 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.79 | 20.09 | 20.44 | 20.76 | 20.93 | 20.99 | 21.00 | 21.00 | 20.96 | 20.69 | 20.16 | 19.73 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.85 | 19.85 | 19.85 | 19.85 | 19.86 | 19.86 | 19.86 | 19.86 | 19.86 | 19.86 | 19.85 | 19.85 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.90 | 0.77 | 0.58 | 0.39 | 0.25 | 0.29 | 0.52 | 0.84 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.27 | 18.70 | 19.19 | 19.61 | 19.80 | 19.85 | 19.86 | 19.86 | 19.83 | 19.54 | 18.81 | 18.19 | (90) |

Living area fraction — Living area ÷ (4) = 0.57 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.14 | 19.49 | 19.90 | 20.26 | 20.44 | 20.50 | 20.51 | 20.51 | 20.47 | 20.19 | 19.58 | 19.06 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.14 | 19.49 | 19.90 | 20.26 | 20.44 | 20.50 | 20.51 | 20.51 | 20.47 | 20.19 | 19.58 | 19.06 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.96 | 0.90 | 0.78 | 0.61 | 0.43 | 0.30 | 0.34 | 0.57 | 0.86 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 725.18 | 929.01 | 1064.16 | 1078.40 | 919.11 | 641.88 | [illegible] | 449.85 | 676.92 | 833.87 | 744.83 | 669.36 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | [illegible] | [illegible] | 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] | 1661.13 | 1631.19 | 1495.75 | 1260.43 | 968.68 | [illegible] | [illegible] | [illegible] | 703.72 | 1062.90 | 1386.07 | 1655.14 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 696.35 | 471.87 | 321.10 | 131.06 | 36.88 | 0.00 | 0.00 | 0.00 | 0.00 | 170.40 | 461.69 | 733.42 | |

∑(98)1...5, 10...12 = 3022.77 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 34.95 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 3022.77 | | | (98) |
| Space heat from heat pump | | (98) x (304a) x (305) x (306) = | 3173.91 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1817.51 | | | (64) |
| Water heat from heat pump | | (64) x (303a) x (305a) x (306) = | 1908.39 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 50.82 | (313) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | | |
| Total electricity for the above, kWh/year | | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | | 366.04 | (332) |
| Total delivered energy for all uses | | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 5448.33 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 3173.91 | x | 4.24 | x 0.01 = | 134.57 | (340a) |
| Water heating from heat pump | 1908.39 | x | 4.24 | x 0.01 = | 80.92 | (342a) |
| Electricity for lighting | 366.04 | x | 13.19 | x 0.01 = | 48.28 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 383.77 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.23 | (357) |
| SAP value | 82.90 | |
| 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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1452.08 | x | 0.519 | = | 753.63 | (367) |
| Electrical energy for community heat distribution | 50.82 | x | 0.519 | = | 26.38 | (372) |
| Total CO2 associated with community systems | | | | | 780.01 | (373) |
| Total CO2 associated with space and water heating | | | | | 780.01 | (376) |
| Electricity for lighting | 366.04 | x | 0.519 | = | 189.97 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 969.98 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 11.21 | (384) |
| EI value | | | | | 90.12 | |
| EI rating (section 14) | | | | | 90 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1452.08 | x | 3.07 | = | 4457.90 | (367) |
| Electrical energy for community heat distribution | 50.82 | x | 3.07 | = | 156.03 | (372) |
| Total primary energy associated with community systems | | | | | 4613.93 | (373) |
| Total primary energy associated with space and water heating | | | | | 4613.93 | (376) |
| Electricity for lighting | 366.04 | x | 3.07 | = | 1123.74 | (379) |
| Primary energy kWh/year | | | | | 5737.66 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 66.33 | (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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 5 04 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 72.67 | (1a) | x | 2.50 | (2a) | = | 181.68 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 72.67 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 181.68 | (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) = | 0.11 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.31 | (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) = | 0.24 | (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 | 0.31 | 0.30 | 0.29 | 0.26 | 0.26 | 0.23 | 0.23 | 0.22 | 0.24 | 0.26 | 0.27 | 0.28 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d) | 0.55 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.52 | 0.53 | 0.53 | 0.54 | 0.54 | (24d) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25) | 0.55 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.52 | 0.53 | 0.53 | 0.54 | 0.54 | (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 | | | 25.07 | x | 1.24 | = | 30.98 | | | (27) |
| External wall | | | 30.28 | x | 0.18 | = | 5.45 | | | (29a) |
| Party wall | | | 38.70 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 72.67 | x | 0.12 | = | 8.72 | | | (30) |
| Total area of external elements ∑A, m² | | | 128.02 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 45.15 | (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 | | 17.76 | (36) |
| Total fabric heat loss | (33) + (36) = | 62.91 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 32.79 | 32.68 | 32.57 | 32.07 | 31.98 | 31.54 | 31.54 | 31.46 | 31.71 | 31.98 | 32.17 | 32.37 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 95.70 | 95.59 | 95.48 | 94.98 | 94.88 | 94.44 | 94.44 | 94.36 | 94.61 | 94.88 | 95.07 | 95.27 | |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.32 | 1.32 | 1.31 | 1.31 | 1.31 | 1.30 | 1.3[illegible] | 1.30 | 1.30 | 1.31 | 1.31 | 1.31 | |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 3[illegible] | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

Average = ∑(39)1...12/12 = 94.98 (39)

Average = ∑(40)1...12/12 = 1.31 (40)

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.31 | (42) |
| Annual average hot water usage in litres per day Vd,average (25 x N) + 36 | 89.04 | (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) | 97.95 | 94.39 | 90.82 | 87.2[illegible] | 83.70 | 80.14 | 80.14 | 83.70 | 87.26 | 90.82 | 94.39 | 97.95 | |
| Energy content of hot water used = 4.18 x Vd,m x nm x ΔTm/3600 kWh/month (see Tables 1b, 1c 1d) | 145.25 | 127.04 | 131.09 | 114.[illegible] | 109.66 | 94.63 | 87.69 | 100.63 | 101.83 | 118.67 | 129.54 | 140.67 | |
| Distribution loss 0.15 x (45)m | 21.79 | 19.06 | 19.66 | 17.14 | 16.45 | 14.19 | 13.15 | 15.09 | 15.27 | 17.80 | 19.43 | 21.10 | (46) |

∑(44)1...12 = 1068.51 (44)

∑(45)1...12 = 1400.99 (45)

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.20 | 151.38 | 158.04 | 140.37 | 136.61 | 120.71 | 114.64 | 127.57 | 127.91 | 145.62 | 155.62 | 167.62 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.20 | 151.38 | 158.04 | 140.37 | 136.61 | 120.71 | 114.64 | 127.57 | 127.91 | 145.62 | 155.62 | 167.62 | |

∑(64)1...12 = 1718.28 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 69.85 | 61.71 | 65.15 | 58.86 | 58.02 | 52.33 | 50.72 | 55.02 | 54.72 | 61.02 | 63.93 | 68.33 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.14 | 16.11 | 13.10 | 9.92 | 7.41 | 6.26 | 6.[illegible] | 8.79 | 11.80 | 14.98 | 17.49 | 18.64 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 203.45 | 205.56 | 200.24 | 188.91 | 174.62 | 161.18 | 1[illegible]20 | 1[illegible]09 | 155.41 | 166.74 | 181.03 | 194.47 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | [illegible].55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.3[illegible] | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | (71) |
| Water heating gains (Table 5) | 93.89 | 91.83 | 87.56 | 81.76 | 77.99 | 72.68 | 68.17 | 73.95 | 76.00 | 82.01 | 88.80 | 91.84 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 373.11 | 371.14 | 358.54 | 3[illegible]22 | 317.65 | 297.75 | 284.77 | 290.47 | 300.85 | 321.37 | 344.96 | 362.59 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthEast | 0.77 | x | 13.39 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 172.08 | (77) |
| NorthWest | 0.77 | x | 6.14 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 24.20 | (81) |
| NorthEast | 0.77 | x | 3.44 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 13.56 | (75) |
| SouthWest | 0.77 | x | 2.10 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 26.99 | (79) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 236.82 | 415.93 | 602.40 | 802.23 | 949.52 | 965.07 | 921.10 | 807.79 | 671.06 | 468.67 | 285.93 | 201.19 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 609.93 | 787.06 | 960.93 | 1140.45 | 1267.17 | 1262.82 | 1205.87 | 1098.25 | 971.91 | 790.03 | 630.89 | 563.78 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | | | | | | | | | | | | | |
| | 0.99 | 0.98 | 0.93 | 0.82 | 0.65 | 0.47 | 0.34 | 0.39 | 0.63 | 0.90 | 0.98 | 0.99 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | | | | | | | | | | | | | |
| | 19.75 | 20.03 | 20.39 | 20.73 | 20.92 | 20.99 | 21.00 | 21.00 | 20.95 | 20.65 | 20.12 | 19.69 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C) | | | | | | | | | | | | | |
| | 19.83 | 19.83 | 19.83 | 19.84 | 19.84 | 19.84 | 19.84 | 19.84 | 19.84 | 19.84 | 19.83 | 19.83 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | | | | | | | | | | | | | |
| | 0.99 | 0.97 | 0.91 | 0.78 | 0.58 | 0.39 | 0.25 | 0.29 | 0.54 | 0.86 | 0.97 | 0.99 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | | | | | | | | | | | | | |
| | 18.21 | 18.61 | 19.10 | 19.56 | 19.77 | 19.83 | 19.84 | 19.84 | 19.81 | 19.47 | 18.74 | 18.12 | (90) |

Living area fraction — Living area ÷ (4) = 0.39 (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 | | | | | | | | | | | | | |
| | 18.82 | 19.17 | 19.61 | 20.02 | 20.23 | 20.29 | 20.30 | 20.30 | 20.26 | 19.94 | 19.28 | 18.74 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | | | | | | | | | | | | | |
| | 18.82 | 19.17 | 19.61 | 20.02 | 20.23 | 20.29 | 20.30 | 20.30 | 20.26 | 19.94 | 19.28 | 18.74 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | | | | | | | | | | | | | |
| | 0.99 | 0.96 | 0.91 | 0.79 | 0.61 | 0.42 | [illegible] | 0.33 | 0.57 | 0.86 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | | |
| | 601.52 | 757.92 | 872.98 | 897.35 | 767.58 | 530.82 | [illegible] | [illegible] | 558.49 | 681.99 | 612.00 | 558.05 | (95) |
| Monthly average external temperature from Table U1 | | | | | | | | | | | | | |
| | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | [illegible] | 16.60 | [illegible] | 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] | | | | | | | | | | | | | |
| | 1389.12 | 1363.88 | 1251.59 | 1056.36 | [illegible] | 537.12 | [illegible] | 367.55 | 582.55 | 885.91 | 1158.11 | 1385.37 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | | | | | | | | | | | | | |
| | 585.97 | 407.20 | 281.69 | 114.49 | [illegible] | 0.00 | 0.00 | 0.00 | 0.00 | 151.71 | 393.20 | 615.52 | |

∑(98)1...5, 10...12 = 2580.66 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 35.51 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 2580.66 | | | (98) |
| Space heat from heat pump | | (98) x (304a) x (305) x (306) = | 2709.69 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1718.28 | | | (64) |
| Water heat from heat pump | | (64) x (303a) x (305a) x (306) = | 1804.19 | (310a) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Electricity used for heat distribution | | | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 45.14 | (313) |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | | |
| Total electricity for the above, kWh/year | | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | | 320.31 | (332) |
| Total delivered energy for all uses | | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4834.20 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 2709.69 | x | 4.24 | x 0.01 = | 114.89 | (340a) |
| Water heating from heat pump | 1804.19 | x | 4.24 | x 0.01 = | 76.50 | (342a) |
| Electricity for lighting | 320.31 | x | 13.19 | x 0.01 = | 42.25 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 353.64 | (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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | [illegible] | x | 0.519 | = | 669.34 | (367) |
| Electrical energy for community heat distribution | 45.14 | x | 0.519 | = | 23.43 | (372) |
| Total CO2 associated with community systems | | | | | 692.77 | (373) |
| Total CO2 associated with space and water heating | | | | | 692.77 | (376) |
| Electricity for lighting | 320.31 | x | 0.519 | = | 166.24 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 859.01 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 11.82 | (384) |
| EI value | | | | | 90.22 | |
| EI rating (section 14) | | | | | 90 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1289.68 | x | 3.07 | = | 3959.32 | (367) |
| Electrical energy for community heat distribution | 45.14 | x | 3.07 | = | 138.58 | (372) |
| Total primary energy associated with community systems | | | | | 4097.90 | (373) |
| Total primary energy associated with space and water heating | | | | | 4097.90 | (376) |
| Electricity for lighting | 320.31 | x | 3.07 | = | 983.36 | (379) |
| Primary energy kWh/year | | | | | 5081.26 | (383) |

| | | |
|---|---|---|
| Dwelling primary energy rate kWh/m2/year | 69.92 | (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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A G 01 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.40 | (1a) | x | 3.00 | (2a) | = | 223.20 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.40 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 223.20 | (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 | 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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.33 | (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) = | 0.26 | (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 | 0.33 | 0.32 | 0.32 | 0.29 | 0.28 | 0.25 | 0.25 | 0.24 | 0.26 | 0.28 | 0.29 | 0.30 | (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 | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (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 | | | 30.15 | x | 1.24 | = | 37.26 | | | (27) |
| Exposed floor | | | 74.40 | x | 0.12 | = | 8.93 | | | (28b |
| External wall | | | 59.58 | x | 0.18 | = | 10.72 | | | (29a) |
| Party wall | | | 62.62 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 164.13 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 56.91 | (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 | | 23.35 | (36) |
| Total fabric heat loss | (33) + (36) = | 80.26 | (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) | 40.85 | 40.69 | 40.54 | 39.82 | 39.69 | 39.06 | 39.06 | 38.94 | 39.30 | 39.69 | 39.96 | 40.24 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 121.11 | 120.96 | 120.80 | 120.08 | 119.95 | 119.32 | 119.32 | 119.21 | 119.56 | 119.95 | 120.22 | 120.51 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 120.08 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.63 | 1.63 | 1.62 | 1.61 | 1.61 | 1.60 | [illegible] | 1.60 | 1.61 | 1.61 | 1.62 | 1.62 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.61 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | [illegible] | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.35 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.97 | (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) | 98.96 | 95.36 | 91.77 | 88.17 | 84.57 | 80.97 | 80.97 | 84.57 | 88.17 | 91.77 | 95.36 | 98.96 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1079.59 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x DTm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.76 | 128.36 | 132.45 | [illegible] | 110.80 | 95.61 | 88.60 | 101.67 | 102.88 | 119.90 | 130.88 | 142.13 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1415.52 | (45) |
| Distribution loss 0.15 x (45)m | 22.01 | 19.25 | 19.87 | 17.32 | 16.62 | 14.34 | 13.29 | 15.25 | 15.43 | 17.99 | 19.63 | 21.32 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 | |

∑(64)1...12 = 1732.81 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.36 | 62.15 | 65.60 | 59.26 | 58.40 | 52.65 | 51.02 | 55.36 | 55.07 | 61.43 | 64.38 | 68.82 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.48 | 16.42 | 13.35 | 10.11 | 7.56 | 6.38 | [illegible] | 8.96 | 12.03 | 15.27 | 17.82 | 19.00 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 207.34 | 209.49 | 204.07 | 192.53 | 177.96 | 164.26 | [illegible] | [illegible] | 158.39 | 169.93 | 184.50 | 198.19 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | (71) |
| Water heating gains (Table 5) | 94.56 | 92.49 | 88.17 | 82.30 | 78.49 | 73.13 | 68.57 | 74.41 | 76.49 | 82.56 | 89.42 | 92.49 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 378.61 | 376.62 | 363.81 | [illegible] | 322.23 | 302.00 | 288.80 | 294.56 | 305.12 | 325.98 | 349.96 | 367.91 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.68 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 214.36 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |
| NorthWest | 0.77 | x | 10.00 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 39.41 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 298.36 | 521.30 | 748.04 | 985.13 | 1156.62 | 1171.66 | 1119.87 | 988.35 | 829.58 | 585.52 | 359.75 | 253.79 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 676.97 | 897.92 | 1111.85 | 1328.29 | 1478.85 | 1473.65 | 1408.67 | 1282.91 | 1134.70 | 911.50 | 709.71 | 621.70 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.97 | 0.93 | 0.83 | 0.67 | 0.50 | 0.37 | 0.42 | 0.65 | 0.90 | 0.98 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.43 | 19.75 | 20.16 | 20.59 | 20.86 | 20.97 | 20.99 | 20.99 | 20.90 | 20.50 | 19.86 | 19.36 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.59 | 19.59 | 19.60 | 19.60 | 19.60 | 19.61 | 19.61 | 19.61 | 19.61 | 19.60 | 19.60 | 19.60 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.91 | 0.78 | 0.59 | 0.40 | 0.25 | 0.30 | 0.55 | 0.86 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17.58 | 18.04 | 18.62 | 19.18 | 19.49 | 19.59 | 19.61 | 19.61 | 19.55 | 19.09 | 18.21 | 17.49 | (90) |

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.24 | 18.65 | 19.17 | 19.68 | 19.97 | 20.08 | 20.10 | 20.10 | 20.03 | 19.59 | 18.80 | 18.15 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.24 | 18.65 | 19.17 | 19.68 | 19.97 | 20.08 | 20.10 | 20.10 | 20.03 | 19.59 | 18.80 | 18.15 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.98 | 0.95 | 0.90 | 0.78 | 0.62 | 0.43 | 0.29 | 0.34 | 0.58 | 0.86 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 664.72 | 857.31 | 999.08 | 1041.80 | 911.13 | 638.18 | 415.05 | 43[illegible]5 | 661.26 | 780.04 | 683.79 | 613.20 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16[illegible] | 16.4[illegible] | 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] | 1687.94 | 1663.10 | 1530.42 | 1294.76 | 992[illegible] | 653.[illegible] | 417.66 | 440.81 | 708.93 | 1078.80 | 1406.65 | 1681.57 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 761.27 | 541.49 | 395.31 | 182.13 | 60.52 | 0.0[illegible] | 0.00 | 0.00 | 0.00 | 222.28 | 520.46 | 794.87 | |

∑(98)1...5, 10...12 = 3478.34 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 46.75 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 3478.34 | | | (98) |
| Space heat from heat pump | | (98) x (304a) x (305) x (306) = | 3652.25 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1732.81 | | | (64) |
| Water heat from heat pump | | (64) x (303a) x (305a) x (306) = | 1819.45 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 54.72 | (313) |

| | | |
|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | |
| Total electricity for the above, kWh/year | 0.00 | (331) |
| Electricity for lighting (Appendix L) | 326.44 | (332) |
| Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 5798.15 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 3652.25 | x | 4.24 | x 0.01 = | 154.86 | (340a) |
| Water heating from heat pump | 1819.45 | x | 4.24 | x 0.01 = | 77.14 | (342a) |
| Electricity for lighting | 326.44 | x | 13.19 | x 0.01 = | 43.06 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 395.06 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.39 | (357) |
| SAP value | 80.61 | |
| SAP rating (section 13) | 81 | (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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1563.34 | x | 0.519 | = | 811.38 | (367) |
| Electrical energy for community heat distribution | [illegible] | x | 0.519 | = | 28.40 | (372) |
| Total CO2 associated with community systems | | | | | 839.77 | (373) |
| Total CO2 associated with space and water heating | | | | | 839.77 | (376) |
| Electricity for lighting | 326.44 | x | 0.519 | = | 169.42 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 1009.20 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 13.56 | (384) |
| EI value | | | | | 88.67 | |
| EI rating (section 14) | | | | | 89 | (385) |
| EI band | | | | | B | |





## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1563.34 | x | 3.07 | = | 4799.47 | (367) |
| Electrical energy for community heat distribution | 54.72 | x | 3.07 | = | 167.98 | (372) |
| Total primary energy associated with community systems | | | | | 4967.45 | (373) |
| Total primary energy associated with space and water heating | | | | | 4967.45 | (376) |
| Electricity for lighting | 326.44 | x | 3.07 | = | 1002.18 | (379) |
| Primary energy kWh/year | | | | | 5969.63 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 80.24 | (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.

| | | | |
|---|---|---|---|
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## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 76.52 | (1a) | x | 3.00 | (2a) | = | 229.56 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 76.52 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 229.56 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.33 | (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) = | 0.26 | (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 | 0.33 | 0.32 | 0.31 | 0.28 | 0.28 | 0.24 | 0.24 | 0.24 | 0.26 | 0.28 | 0.29 | 0.30 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (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 | | | 19.92 | x | 1.24 | = | 24.62 | | | (27) |
| Exposed floor | | | 76.52 | x | 0.12 | = | 9.18 | | | (28b |
| External wall | | | 23.53 | x | 0.18 | = | 4.24 | | | (29a) |
| Party wall | | | 85.38 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 119.97 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 38.03 | (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 | | 16.12 | (36) |
| Total fabric heat loss | (33) + (36) = | 54.15 | (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) | 41.92 | 41.76 | 41.61 | 40.89 | 40.75 | 40.12 | 40.12 | 40.01 | 40.37 | 40.75 | 41.03 | 41.31 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 96.07 | 95.92 | 95.76 | 95.04 | 94.90 | 94.28 | 94.28 | 94.16 | 94.52 | 94.90 | 95.18 | 95.46 | |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.26 | 1.25 | 1.25 | 1.24 | 1.24 | 1.23 | [illegible] | 1.23 | 1.24 | 1.24 | 1.24 | 1.25 | |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | [illegible] | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

Average = ∑(39)1...12/12 = 95.04 (39)

Average = ∑(40)1...12/12 = 1.24 (40)

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.39 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 91.05 | (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) | 100.15 | 96.51 | 92.87 | 89.23 | 85.58 | 81.94 | 81.94 | 85.58 | 89.23 | 92.87 | 96.51 | 100.15 | |
| Energy content of hot water used = 4.18 x Vd,m x nm x ΔTm/3600 kWh/month (see Tables 1b, 1c 1d) | 148.52 | 129.90 | 134.04 | [illegible] | 112.13 | 96.76 | 89.66 | 102.89 | 104.12 | 121.34 | 132.45 | 143.83 | |
| Distribution loss 0.15 x (45)m | 22.28 | 19.48 | 20.11 | 17.53 | 16.82 | 14.51 | 13.45 | 15.43 | 15.62 | 18.20 | 19.87 | 21.58 | (46) |

∑(44)1...12 = 1092.55 (44)

∑(45)1...12 = 1432.51 (45)

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 |

∑(64)1...12 = 1749.80 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.94 | 62.66 | 66.13 | 59.72 | 58.84 | 53.04 | 51.37 | 55.77 | 55.48 | 61.90 | 64.90 | 69.38 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.90 | 16.79 | 13.65 | 10.34 | 7.73 | 6.52 | [illegible] | 9.16 | 12.30 | 15.61 | 18.22 | 19.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 212.01 | 214.21 | 208.67 | 196.87 | 181.97 | 167.97 | [illegible] | [illegible] | 161.96 | 173.76 | 188.66 | 202.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | [illegible] | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | (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) | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | (71) |
| Water heating gains (Table 5) | 95.35 | 93.25 | 88.88 | 82.94 | 79.09 | 73.66 | 69.05 | 74.96 | 77.06 | 83.20 | 90.14 | 93.26 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 385.17 | 383.15 | 370.11 | [illegible] | 327.69 | 307.05 | 293.61 | 299.43 | 310.21 | 331.48 | 355.93 | 374.25 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.45 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 211.40 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 255.99 | 436.05 | 596.62 | 739.25 | 828.02 | 822.03 | 792.52 | 726.30 | 646.02 | 481.93 | 306.62 | 219.08 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 641.16 | 819.20 | 966.73 | 1088.30 | 1155.70 | 1129.08 | 1086.13 | 1025.73 | 956.23 | 813.41 | 662.55 | 593.32 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.94 | 0.85 | 0.70 | 0.52 | 0.38 | 0.42 | 0.64 | 0.89 | 0.98 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.83 | 20.10 | 20.42 | 20.73 | 20.91 | 20.98 | 21.00 | 20.99 | 20.95 | 20.69 | 20.19 | 19.78 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.88 | 19.88 | 19.88 | 19.89 | 19.89 | 19.89 | 19.89 | 19.90 | 19.89 | 19.89 | 19.89 | 19.88 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.97 | 0.92 | 0.81 | 0.63 | 0.44 | 0.29 | 0.32 | 0.55 | 0.86 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.36 | 18.74 | 19.18 | 19.59 | 19.81 | 19.88 | 19.89 | 19.89 | 19.86 | 19.56 | 18.87 | 18.28 | (90) |

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.87 | 19.21 | 19.61 | 19.99 | 20.19 | 20.27 | 20.28 | 20.28 | 20.24 | 19.95 | 19.33 | 18.80 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.87 | 19.21 | 19.61 | 19.99 | 20.19 | 20.27 | 20.28 | 20.28 | 20.24 | 19.95 | 19.33 | 18.80 | (93) |

## 8. Space heating requirement

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | | | | | | | | | | | | |
| 0.99 | 0.96 | 0.91 | 0.81 | 0.65 | 0.47 | 0.32 | 0.35 | 0.58 | 0.86 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | |
| 632.11 | 788.29 | 882.71 | 883.49 | 755.26 | 525.98 | 345[illegible] | 363.22 | 557.79 | 699.15 | 641.78 | 587.17 | (95) |
| Monthly average external temperature from Table U1 | | | | | | | | | | | | |
| 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | [illegible]60 | [illegible]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] | | | | | | | | | | | | |
| 1399.60 | 1372.92 | 1255.67 | 1053.70 | 805.99 | [illegible]08 | [illegible]46.57 | [illegible]4.94 | 580.38 | 887.57 | 1164.01 | 1393.58 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | | | | | | | | | | | | |
| 571.02 | 392.87 | 277.48 | 122.55 | 37.74 | 0.00 | 0.00 | 0.00 | 0.00 | 140.18 | 376.01 | 599.96 | |

∑(98)1...5, 10...12 = 2517.81 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 32.90 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 2517.81 | | | (98) |
| Space heat from heat pump | | (98) x (304a) x (305) x (306) = | 2643.70 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1749.80 | | | (64) |
| Water heat from heat pump | | (64) x (303a) x (305a) x (306) = | 1837.29 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 44.81 | (313) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | | |
| Total electricity for the above, kWh/year | | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | | 333.80 | (332) |
| Total delivered energy for all uses | | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4814.80 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 2643.70 | x | 4.24 | x 0.01 = | 112.09 | (340a) |
| Water heating from heat pump | 1837.29 | x | 4.24 | x 0.01 = | 77.90 | (342a) |
| Electricity for lighting | 333.80 | x | 13.19 | x 0.01 = | 44.03 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 354.02 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.22 | (357) |
| SAP value | 82.93 | |
| 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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1280.28 | x | 0.519 | = | 664.47 | (367) |
| Electrical energy for community heat distribution | 44.81 | x | 0.519 | = | 23.26 | (372) |
| Total CO2 associated with community systems | | | | | 687.72 | (373) |
| Total CO2 associated with space and water heating | | | | | 687.72 | (376) |
| Electricity for lighting | 333.80 | x | 0.519 | = | 173.24 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 860.97 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 11.25 | (384) |
| EI value | | | | | 90.51 | |
| EI rating (section 14) | | | | | 91 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 1280.28 | x | 3.07 | = | 3930.47 | (367) |
| Electrical energy for community heat distribution | 44.81 | x | 3.07 | = | 137.57 | (372) |
| Total primary energy associated with community systems | | | | | 4068.04 | (373) |
| Total primary energy associated with space and water heating | | | | | 4068.04 | (376) |
| Electricity for lighting | 333.80 | x | 3.07 | = | 1024.77 | (379) |
| Primary energy kWh/year | | | | | 5092.81 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 66.56 | (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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A G 04 above gym Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 54.41 | (1a) | x | 3.00 | (2a) | = | 163.23 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 54.41 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 163.23 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.32 | (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) = | 0.25 | (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 | 0.32 | 0.31 | 0.31 | 0.27 | 0.27 | 0.24 | 0.24 | 0.23 | 0.25 | 0.27 | 0.28 | 0.29 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.54 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.54 | (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 | | | 15.56 | x | 1.24 | = | 19.23 | | | (27) |
| Exposed floor | | | 54.41 | x | 0.06 | = | 3.26 | | | (28b |
| External wall | | | 21.39 | x | 0.18 | = | 3.85 | | | (29a) |
| Party wall | | | 76.23 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 91.36 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 26.34 | (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 | | 7.66 | (36) |
| Total fabric heat loss | (33) + (36) = | 34.01 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 29.67 | 29.56 | 29.46 | 28.97 | 28.88 | 28.45 | 28.45 | 28.37 | 28.62 | 28.88 | 29.06 | 29.26 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 63.67 | 63.57 | 63.46 | 62.97 | 62.88 | 62.46 | 62.46 | 62.38 | 62.62 | 62.88 | 63.07 | 63.26 | |

Average = ∑(39)1...12/12 = 62.97 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.17 | 1.17 | 1.17 | 1.16 | 1.16 | 1.15 | 1.1[illegible] | 1.15 | 1.15 | 1.16 | 1.16 | 1.16 | |

Average = ∑(40)1...12/12 = 1.16 (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 | 3[illegible].00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | | |
|---|---|---|---|
| Assumed occupancy, N | | 1.82 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) [illegible] | | 77.43 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 85.17 | 82.07 | 78.97 | 75.88 | 72.78 | 69.68 | 69.68 | 72.78 | 75.88 | 78.97 | 82.07 | 85.17 | |

∑(44)1...12 = 929.11 (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 ΔTm/3600 kWh/month (see Tables 1b, 1c 1d) | 126.30 | 110.47 | 113.99 | 99.[illegible] | 95.36 | 82.29 | 76.25 | 87.50 | 88.54 | 103.19 | 112.64 | 122.32 | |

∑(45)1...12 = 1218.22 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 18.95 | 16.57 | 17.10 | 14.91 | 14.30 | 12.34 | 11.44 | 13.12 | 13.28 | 15.48 | 16.90 | 18.35 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 153.25 | 134.81 | 140.94 | 125.46 | 122.31 | 108.36 | 103.20 | 114.45 | 114.62 | 130.14 | 138.72 | 149.27 | (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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 153.25 | 134.81 | 140.94 | 125.46 | 122.31 | 108.36 | 103.20 | 114.45 | 114.62 | 130.14 | 138.72 | 149.27 |

∑(64)1...12 = 1535.51 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63.55 | 56.20 | 59.46 | 53.91 | 53.26 | 48.22 | 46.91 | 50.65 | 50.30 | 55.87 | 58.32 | 62.23 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 14.14 | 12.56 | 10.22 | 7.74 | 5.78 | 4.88 | [illegible] | 6.86 | 9.20 | 11.68 | 13.64 | 14.54 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 158.66 | 160.31 | 156.16 | 147.33 | 136.18 | 125.70 | [illegible] | [illegible] | 121.20 | 130.03 | 141.18 | 151.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | [illegible] | 32.10 | [illegible] | 32.10 | 32.10 | 32.10 | 32.10 | (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) | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | [illegible] | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | (71) |
| Water heating gains (Table 5) | 85.42 | 83.63 | 79.92 | 74.87 | 71.59 | 66.98 | 63.05 | 68.08 | 69.87 | 75.09 | 80.99 | 83.64 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 308.53 | 306.81 | 296.60 | [illegible] | 263.85 | 247.86 | 237.33 | 242.29 | 250.57 | 267.11 | 286.12 | 300.14 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthEast | 0.77 | x | 7.78 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 99.98 | (77) |
| NorthEast | 0.77 | x | 7.78 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 30.66 | (75) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 130.64 | 232.71 | 345.46 | 473.38 | 571.61 | 585.68 | 557.08 | 481.02 | 389.32 | 264.49 | 158.33 | 110.60 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 439.17 | 539.52 | 642.06 | 753.62 | 835.46 | 833.54 | 794.41 | 723.31 | 639.89 | 531.60 | 444.45 | 410.74 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.94 | 0.84 | 0.66 | 0.47 | 0.34 | 0.39 | 0.64 | 0.91 | 0.98 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.92 | 20.15 | 20.46 | 20.77 | 20.94 | 20.99 | 21.00 | 21.00 | 20.96 | 20.70 | 20.24 | 19.87 | (87) |

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

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

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.97 | 0.93 | 0.80 | 0.60 | 0.40 | 0.26 | 0.31 | 0.56 | 0.87 | 0.98 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.53 | 18.86 | 19.30 | 19.72 | 19.91 | 19.96 | 19.96 | 19.96 | 19.93 | 19.64 | 19.00 | 18.47 | (90) |

Living area fraction — Living area ÷ (4) = 0.53 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.27 | 19.55 | 19.92 | 20.28 | 20.46 | 20.51 | 20.52 | 20.51 | 20.48 | 20.21 | 19.66 | 19.22 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.27 | 19.55 | 19.92 | 20.28 | 20.46 | 20.51 | 20.52 | 20.51 | 20.48 | 20.21 | 19.66 | 19.22 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | | | | | | | | | | | | | |
| | 0.99 | 0.97 | 0.93 | 0.81 | 0.63 | 0.44 | 0.31 | 0.35 | 0.60 | 0.88 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | | |
| | 434.04 | 523.79 | 594.38 | 611.75 | 525.44 | 365.62 | 244[illegible] | 255.77 | 384.73 | 468.87 | 433.23 | 407.14 | (95) |
| Monthly average external temperature from Table U1 | | | | | | | | | | | | | |
| | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | [illegible]60 | [illegible]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] | | | | | | | | | | | | | |
| | 953.38 | 931.12 | 851.42 | 716.74 | 550.84 | 3[illegible]05 | [illegible]44.53 | [illegible]6.67 | 399.74 | 604.21 | 792.42 | 950.01 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x [illegible]m | | | | | | | | | | | | | |
| | 386.39 | 273.73 | 191.24 | 75.59 | [illegible]18.90 | 0.00 | [illegible]0.00 | 0.00 | 0.00 | 100.70 | 258.62 | 403.89 | |

∑(98)1...5, 10...12 = 1709.06 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 31.41 (99)

## 9b. Energy requirements - community heating scheme

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary system (table 11) | '0' if none | 0.00 | (301) |
| Fraction of space heat from community system | 1 - (301) = | 1.00 | (302) |
| Fraction of community heat from heat pump | | 1.00 | (303a) |
| Fraction of total space heat from community heat pump | (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 | 1709.06 | | | (98) |
| Space heat from heat pump | | (98) x (304a) x (305) x (306) = | 1794.51 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1535.51 | | | (64) |
| Water heat from heat pump | | (64) x (303a) x (305a) x (306) = | 1612.28 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 34.07 | (313) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | | |
| Total electricity for the above, kWh/year | | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | | 249.81 | (332) |
| Total delivered energy for all uses | | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 3656.60 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from heat pump | 1794.51 | x | 4.24 | x 0.01 = | 76.09 | (340a) |
| Water heating from heat pump | 1612.28 | x | 4.24 | x 0.01 = | 68.36 | (342a) |
| Electricity for lighting | 249.81 | x | 13.19 | x 0.01 = | 32.95 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 297.40 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.26 | (357) |
| SAP value | 82.47 | |
| 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 heat pump | 350.00 | | | | | (367a) |
| CO2 emissions from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 973.37 | x | 0.519 | = | 505.18 | (367) |
| Electrical energy for community heat distribution | 34.07 | x | 0.519 | = | 17.68 | (372) |
| Total CO2 associated with community systems | | | | | 522.86 | (373) |
| Total CO2 associated with space and water heating | | | | | 522.86 | (376) |
| Electricity for lighting | 249.81 | x | 0.519 | = | 129.65 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 652.51 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 11.99 | (384) |
| EI value | | | | | 91.20 | |
| EI rating (section 14) | | | | | 91 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of heat pump | 350.00 | | | | | (367a) |
| Primary energy from heat pump [(307a)+(310a)] x 100 ÷ (367a) = | 973.37 | x | 3.07 | = | 2988.25 | (367) |
| Electrical energy for community heat distribution | 34.07 | x | 3.07 | = | 104.59 | (372) |
| Total primary energy associated with community systems | | | | | 3092.84 | (373) |
| Total primary energy associated with space and water heating | | | | | 3092.84 | (376) |
| Electricity for lighting | 249.81 | x | 3.07 | = | 766.90 | (379) |
| Primary energy kWh/year | | | | | 3859.74 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 70.94 | (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.

| | | | |
|---|---|---|---|
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## 1. Overall dwelling dimensions

| | | Area ($m^2$) | | | Average storey height (m) | | | Volume ($m^3$) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.40 | (1a) | x | 2.50 | (2a) | = | 186.00 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.40 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 186.00 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.36 | (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) = | 0.28 | (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 | 0.36 | 0.35 | 0.34 | 0.31 | 0.30 | 0.27 | 0.27 | 0.26 | 0.28 | 0.30 | 0.32 | 0.33 | (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 | 0.56 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.55 | (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 | | | 30.15 | x | 1.24 | = | 37.26 | | | (27) |
| External wall | | | 37.21 | x | 0.18 | = | 6.70 | | | (29a) |
| Party wall | | | 47.00 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 67.36 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 43.96 | (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 | | 16.87 | (36) |
| Total fabric heat loss | (33) + (36) = | 60.83 | (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) | 34.60 | 34.45 | 34.30 | 33.60 | 33.47 | 32.86 | 32.86 | 32.75 | 33.10 | 33.47 | 33.74 | 34.01 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 95.43 | 95.28 | 95.13 | 94.43 | 94.30 | 93.69 | 93.69 | 93.58 | 93.92 | 94.30 | 94.56 | 94.84 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 94.43 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.28 | 1.28 | 1.28 | 1.27 | 1.27 | 1.26 | 1.26 | 1.26 | 1.26 | 1.27 | 1.27 | 1.27 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.27 | (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 | 2.35 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.97 | (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) | 98.96 | 95.36 | 91.77 | 88.17 | 84.57 | 80.97 | 80.97 | 84.57 | 88.17 | 91.77 | 95.36 | 98.96 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1079.59 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.76 | 128.36 | 132.45 | 115.47 | 110.80 | 95.61 | 88.60 | 101.67 | 102.88 | 119.90 | 130.88 | 142.13 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1415.52 | (45) |
| Distribution loss 0.15 x (45)m | 22.01 | 19.25 | 19.87 | 17.32 | 16.62 | 14.34 | 13.29 | 15.25 | 15.43 | 17.99 | 19.63 | 21.32 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 | (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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 |

$\sum(64)1...12$ = 1732.81 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.36 | 62.15 | 65.60 | 59.26 | 58.40 | 52.65 | 51.02 | 55.36 | 55.07 | 61.43 | 64.38 | 68.82 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.48 | 16.42 | 13.35 | 10.11 | 7.56 | 6.38 | 6.89 | 8.96 | 12.03 | 15.27 | 17.82 | 19.00 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 207.34 | 209.49 | 204.07 | 192.53 | 177.96 | 164.26 | 155.12 | 152.96 | 158.39 | 169.93 | 184.50 | 198.19 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | (71) |
| Water heating gains (Table 5) | 94.56 | 92.49 | 88.17 | 82.30 | 78.49 | 73.13 | 68.57 | 74.41 | 76.49 | 82.56 | 89.42 | 92.49 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 378.61 | 376.62 | 363.81 | 343.16 | 322.23 | 302.00 | 288.80 | 294.56 | 305.12 | 325.98 | 349.96 | 367.91 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.68 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 214.36 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |
| NorthWest | 0.77 | x | 10.00 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 39.41 | (81) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts $\sum(74)m...(82)m$ | 298.36 | 521.30 | 748.04 | 985.13 | 1156.62 | 1171.66 | 1119.87 | 988.35 | 829.58 | 585.52 | 359.75 | 253.79 | (83) |
| Total gains - internal and solar (73)m + (83)m | 676.97 | 897.92 | 1111.85 | 1328.29 | 1478.85 | 1473.65 | 1408.67 | 1282.91 | 1134.70 | 911.50 | 709.71 | 621.70 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.90 | 0.76 | 0.57 | 0.40 | 0.29 | 0.33 | 0.55 | 0.85 | 0.97 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.86 | 20.17 | 20.53 | 20.83 | 20.96 | 20.99 | 21.00 | 21.00 | 20.97 | 20.75 | 20.23 | 19.79 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.85 | 19.86 | 19.86 | 19.87 | 19.87 | 19.87 | 19.87 | 19.87 | 19.87 | 19.87 | 19.86 | 19.86 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.95 | 0.87 | 0.71 | 0.51 | 0.33 | 0.22 | 0.25 | 0.47 | 0.81 | 0.96 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.38 | 18.83 | 19.31 | 19.69 | 19.83 | 19.87 | 19.87 | 19.87 | 19.85 | 19.61 | 18.92 | 18.29 | (90) |

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.91 | 19.31 | 19.75 | 20.10 | 20.23 | 20.27 | 20.27 | 20.27 | 20.25 | 20.02 | 19.38 | 18.82 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.91 | 19.31 | 19.75 | 20.10 | 20.23 | 20.27 | 20.27 | 20.27 | 20.25 | 20.02 | 19.38 | 18.82 | (93) |

## 8. Space heating requirement

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

Utilisation factor for gains, ηm

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.98 | 0.95 | 0.87 | 0.72 | 0.53 | 0.36 | 0.24 | 0.28 | 0.50 | 0.81 | 0.96 | 0.99 | (94) |

Useful gains, ηmGm, W (94)m x (84)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 664.27 | 849.67 | 966.64 | 954.19 | 782.38 | 528.24 | 343.77 | 361.75 | 565.40 | 740.29 | 679.82 | 613.26 | (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]

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1393.82 | 1372.61 | 1260.12 | 1057.32 | 804.72 | 531.13 | 344.13 | 362.45 | 577.83 | 887.98 | 1161.56 | 1386.91 | (97) |

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 542.79 | 351.42 | 218.35 | 74.25 | 16.62 | 0.00 | 0.00 | 0.00 | 0.00 | 109.88 | 346.86 | 575.59 |

∑(98)1...5, 10...12 = 2235.75 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 30.05 (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 | 2235.75 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 2347.54 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1732.81 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1819.45 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 41.67 | (313) |

| | | | | | |
|---|---|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | |
| Total electricity for the above, kWh/year | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | 326.44 | (332) |
| Total delivered energy for all uses | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4493.43 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 2347.54 | x | 4.24 | x 0.01 = | 99.54 | (340a) |
| Water heating from boilers | 1819.45 | x | 4.24 | x 0.01 = | 77.14 | (342a) |
| Electricity for lighting | 326.44 | x | 13.19 | x 0.01 = | 43.06 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 339.74 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.20 | (357) |
| SAP value | 83.33 | |
| 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) = | 4655.85 | x | 0.216 | = | 1005.66 | (367) |
| Electrical energy for community heat distribution | | 41.67 | x | 0.519 | = | 21.63 | (372) |
| Total CO2 associated with community systems | | | | | | 1027.29 | (373) |
| Total CO2 associated with space and water heating | | | | | | 1027.29 | (376) |
| Electricity for lighting | | 326.44 | x | 0.519 | = | 169.42 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 1196.72 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 16.08 | (384) |
| EI value | | | | | | 86.57 | |
| 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) = | 4655.85 | x | 1.22 | = | 5680.14 | (367) |
| Electrical energy for community heat distribution | | 41.67 | x | 3.07 | = | 127.93 | (372) |
| Total primary energy associated with community systems | | | | | | 5808.07 | (373) |
| Total primary energy associated with space and water heating | | | | | | 5808.07 | (376) |
| Electricity for lighting | | 326.44 | x | 3.07 | = | 1002.18 | (379) |
| Primary energy kWh/year | | | | | | 6810.25 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | | 91.54 | (384) |

# 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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
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## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.40 | (1a) | x | 2.50 | (2a) | = | 186.00 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.40 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 186.00 | (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 | | 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 | 0.41 | 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, 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 | | | 18.60 | x | 1.33 | = | 24.66 | | | (27) |
| External wall | | | 48.77 | x | 0.18 | = | 8.78 | | | (29a) |
| Party wall | | | 47.00 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 67.37 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 33.44 | (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 | | 9.95 | (36) |
| Total fabric heat loss | (33) + (36) = | 43.39 | (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) | 35.76 | 35.56 | 35.37 | 34.46 | 34.29 | 33.50 | 33.50 | 33.36 | 33.81 | 34.29 | 34.64 | 34.99 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 79.15 | 78.95 | 78.76 | 77.85 | 77.68 | 76.89 | 76.89 | 76.74 | 77.19 | 77.68 | 78.02 | 78.38 | |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.06 | 1.06 | 1.06 | 1.05 | 1.04 | 1.03 | 1.03 | 1.03 | 1.04 | 1.04 | 1.05 | 1.05 | |
| 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) |

Heat transfer coefficient: Average = ∑(39)1...12/12 = 77.85 (39)

Heat loss parameter: Average = ∑(40)1...12/12 = 1.05 (40)

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.35 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.97 | (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) | 98.96 | 95.36 | 91.77 | 88.17 | 84.57 | 80.97 | 80.97 | 84.57 | 88.17 | 91.77 | 95.36 | 98.96 | |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.76 | 128.36 | 132.45 | 115.47 | 110.80 | 95.61 | 88.60 | 101.67 | 102.88 | 119.90 | 130.88 | 142.13 | |
| Distribution loss 0.15 x (45)m | 22.01 | 19.25 | 19.87 | 17.32 | 16.62 | 14.34 | 13.29 | 15.25 | 15.43 | 17.99 | 19.63 | 21.32 | (46) |

∑(44)1...12 = 1079.59 (44)

∑(45)1...12 = 1415.52 (45)

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 174.02 | 152.98 | 159.71 | 141.86 | 138.06 | 121.99 | 115.86 | 128.93 | 129.26 | 147.16 | 157.26 | 169.39 | (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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 174.02 | 152.98 | 159.71 | 141.86 | 138.06 | 121.99 | 115.86 | 128.93 | 129.26 | 147.16 | 157.26 | 169.39 |

∑(64)1...12 = 1736.48 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.61 | 62.38 | 65.85 | 59.50 | 58.65 | 52.90 | 51.27 | 55.61 | 55.31 | 61.68 | 64.62 | 69.07 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.48 | 16.42 | 13.35 | 10.11 | 7.56 | 6.38 | 6.89 | 8.96 | 12.03 | 15.27 | 17.82 | 19.00 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 207.34 | 209.49 | 204.07 | 192.53 | 177.96 | 164.26 | 155.12 | 152.96 | 158.39 | 169.93 | 184.50 | 198.19 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | (69) |
| Pump and fan gains (Table 5a) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |
| Losses e.g. evaporation (Table 5) | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | (71) |
| Water heating gains (Table 5) | 94.90 | 92.82 | 88.51 | 82.64 | 78.83 | 73.47 | 68.91 | 74.75 | 76.82 | 82.90 | 89.75 | 92.83 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 381.95 | 379.95 | 367.15 | 346.50 | 325.56 | 305.33 | 292.14 | 297.89 | 308.46 | 329.31 | 353.29 | 371.24 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 10.29 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 115.71 | (79) |
| SouthEast | 0.77 | x | 2.14 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 24.06 | (77) |
| NorthWest | 0.77 | x | 6.17 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 21.28 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 161.05 | 281.39 | 403.78 | 531.77 | 624.34 | 632.46 | 604.50 | 533.50 | 447.80 | 316.06 | 194.18 | 136.99 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 542.99 | 661.34 | 770.93 | 878.26 | 949.90 | 937.79 | 896.64 | 831.40 | 756.25 | 645.37 | 547.48 | 508.23 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 0.99 | 0.99 | 0.96 | 0.87 | 0.71 | 0.52 | 0.38 | 0.42 | 0.67 | 0.92 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.00 | 20.21 | 20.48 | 20.77 | 20.94 | 20.99 | 21.00 | 21.00 | 20.97 | 20.73 | 20.30 | 19.96 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.03 | 20.03 | 20.03 | 20.04 | 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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.94 | 0.84 | 0.65 | 0.44 | 0.30 | 0.34 | 0.59 | 0.89 | 0.98 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.71 | 19.01 | 19.40 | 19.80 | 19.99 | 20.05 | 20.06 | 20.06 | 20.03 | 19.75 | 19.15 | 18.65 | (90) |

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.16 | 19.43 | 19.78 | 20.15 | 20.33 | 20.38 | 20.39 | 20.39 | 20.36 | 20.10 | 19.56 | 19.12 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.16 | 19.43 | 19.78 | 20.15 | 20.33 | 20.38 | 20.39 | 20.39 | 20.36 | 20.10 | 19.56 | 19.12 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.98 | 0.94 | 0.84 | 0.67 | 0.47 | 0.32 | 0.37 | 0.62 | 0.90 | 0.98 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 538.29 | 646.30 | 725.06 | 740.37 | 637.16 | 440.84 | 291.05 | 305.48 | 467.39 | 577.69 | 536.53 | 505.01 | (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] | 1176.49 | 1147.35 | 1046.22 | 875.46 | 670.37 | 444.80 | 291.47 | 306.29 | 483.42 | 737.76 | 972.34 | 1169.32 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 474.82 | 336.71 | 238.94 | 97.27 | 24.71 | 0.00 | 0.00 | 0.00 | 0.00 | 119.09 | 313.78 | 494.25 | |

∑(98)1...5, 10...12 = 2099.56 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 28.22 (99)

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

**Space heating**

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating fuel (main system 1), kWh/month | 507.82 | 360.12 | 255.55 | 104.03 | 26.43 | 0.00 | 0.00 | 0.00 | 0.00 | 127.37 | 335.59 | 528.61 | |

∑(211)1...5, 10...12 = 2245.52 (211)

**Water heating**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Efficiency of water heater | 87.36 | 86.86 | 85.89 | 83.83 | 81.26 | 79.80 | 79.80 | 79.80 | 79.80 | 84.26 | 86.62 | 87.51 | (217) |
| Water heating fuel, kWh/month | 199.20 | 176.12 | 185.96 | 169.21 | 169.90 | 152.87 | 145.19 | 161.57 | 161.98 | 174.66 | 181.55 | 193.57 | |

∑(219a)1...12 = 2071.79 (219)

**Annual totals**

Space heating fuel - main system 1 — 2245.52

| | | | | |
|---|---|---|---|---|
| Water heating fuel | | | 2071.79 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | |
| central heating pump or water pump within warm air heating unit | | 30.00 | | (230c) |
| boiler flue fan | | 45.00 | | (230e) |
| Total electricity for the above, kWh/year | | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | | 326.44 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | | 4718.75 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2245.52 | x | 3.48 | x 0.01 = | 78.14 | (240) |
| Water heating | 2071.79 | x | 3.48 | x 0.01 = | 72.10 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 326.44 | x | 13.19 | x 0.01 = | 43.06 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 323.19 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.14 | (257) |
| SAP value | 84.14 | |
| 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 | 2245.52 | x | 0.216 | = | 485.03 | (261) |
| Water heating | 2071.79 | x | 0.216 | = | 447.51 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 932.54 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 326.44 | x | 0.519 | = | 169.42 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1140.89 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 15.33 | (273) |
| EI value | | | | | 87.20 | |
| 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 | 2245.52 | x | 1.22 | = | 2739.53 | (261) |
| Water heating | 2071.79 | x | 1.22 | = | 2527.58 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 5267.11 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 326.44 | x | 3.07 | = | 1002.18 | (268) |
| Primary energy kWh/year | | | | | 6499.55 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 87.36 | (273) |

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
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## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 76.52 | (1a) | x | 2.50 | (2a) | = | 191.30 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 76.52 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 191.30 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.36 | (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) = | 0.28 | (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 | 0.35 | 0.35 | 0.34 | 0.30 | 0.30 | 0.26 | 0.26 | 0.26 | 0.28 | 0.30 | 0.31 | 0.32 | (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 | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (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 | | | 19.92 | x | 1.24 | = | 24.62 | | | (27) |
| External wall | | | 12.70 | x | 0.18 | = | 2.29 | | | (29a) |
| Party wall | | | 64.09 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 32.62 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 26.90 | (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 | | 10.94 | (36) |
| Total fabric heat loss | (33) + (36) = | 37.84 | (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) | 35.49 | 35.34 | 35.19 | 34.49 | 34.35 | 33.74 | 33.74 | 33.63 | 33.98 | 34.35 | 34.62 | 34.90 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 73.33 | 73.18 | 73.03 | 72.33 | 72.20 | 71.59 | 71.59 | 71.47 | 71.82 | 72.20 | 72.46 | 72.74 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 72.33 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.96 | 0.96 | 0.95 | 0.95 | 0.94 | 0.94 | 0.94 | 0.93 | 0.94 | 0.94 | 0.95 | 0.95 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.95 | (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 | 2.39 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 91.05 | (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) | 100.15 | 96.51 | 92.87 | 89.23 | 85.58 | 81.94 | 81.94 | 85.58 | 89.23 | 92.87 | 96.51 | 100.15 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1092.55 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 148.52 | 129.90 | 134.04 | 116.86 | 112.13 | 96.76 | 89.66 | 102.89 | 104.12 | 121.34 | 132.45 | 143.83 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1432.51 | (45) |
| Distribution loss 0.15 x (45)m | 22.28 | 19.48 | 20.11 | 17.53 | 16.82 | 14.51 | 13.45 | 15.43 | 15.62 | 18.20 | 19.87 | 21.58 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 | |

∑(64)1...12 = 1749.80 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.94 | 62.66 | 66.13 | 59.72 | 58.84 | 53.04 | 51.37 | 55.77 | 55.48 | 61.90 | 64.90 | 69.38 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.90 | 16.79 | 13.65 | 10.34 | 7.73 | 6.52 | 7.05 | 9.16 | 12.30 | 15.61 | 18.22 | 19.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 212.01 | 214.21 | 208.67 | 196.87 | 181.97 | 167.97 | 158.61 | 156.41 | 161.96 | 173.76 | 188.66 | 202.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | (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) | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | (71) |
| Water heating gains (Table 5) | 95.35 | 93.25 | 88.88 | 82.94 | 79.09 | 73.66 | 69.05 | 74.96 | 77.06 | 83.20 | 90.14 | 93.26 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 385.17 | 383.15 | 370.11 | 349.05 | 327.69 | 307.05 | 293.61 | 299.43 | 310.21 | 331.48 | 355.93 | 374.25 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.45 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 211.40 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 255.99 | 436.05 | 596.62 | 739.25 | 828.02 | 822.03 | 792.52 | 726.30 | 646.02 | 481.93 | 306.62 | 219.08 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 641.16 | 819.20 | 966.73 | 1088.30 | 1155.70 | 1129.08 | 1086.13 | 1025.73 | 956.23 | 813.41 | 662.55 | 593.32 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 0.99 | 0.96 | 0.89 | 0.75 | 0.57 | 0.40 | 0.29 | 0.32 | 0.51 | 0.82 | 0.97 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.25 | 20.50 | 20.75 | 20.92 | 20.99 | 21.00 | 21.00 | 21.00 | 20.99 | 20.89 | 20.53 | 20.19 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.12 | 20.12 | 20.12 | 20.13 | 20.13 | 20.14 | 20.14 | 20.14 | 20.13 | 20.13 | 20.13 | 20.12 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.95 | 0.87 | 0.71 | 0.52 | 0.35 | 0.23 | 0.26 | 0.45 | 0.78 | 0.96 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.13 | 19.49 | 19.83 | 20.05 | 20.12 | 20.14 | 20.14 | 20.14 | 20.13 | 20.02 | 19.55 | 19.06 | (90) |

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.52 | 19.84 | 20.15 | 20.35 | 20.42 | 20.44 | 20.44 | 20.44 | 20.43 | 20.32 | 19.89 | 19.45 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.52 | 19.84 | 20.15 | 20.35 | 20.42 | 20.44 | 20.44 | 20.44 | 20.43 | 20.32 | 19.89 | 19.45 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.98 | 0.95 | 0.87 | 0.72 | 0.54 | 0.37 | 0.25 | 0.28 | 0.47 | 0.79 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 630.15 | 775.06 | 837.88 | 781.70 | 621.46 | 417.03 | 274.59 | 288.45 | 451.73 | 638.96 | 633.53 | 586.22 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1116.21 | 1093.60 | 996.63 | 828.37 | 629.50 | 417.74 | 274.64 | 288.56 | 454.64 | 702.09 | 927.03 | 1109.54 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 361.63 | 214.06 | 118.11 | 33.60 | 5.98 | 0.00 | 0.00 | 0.00 | 0.00 | 46.97 | 211.32 | 389.35 | |

∑(98)1...5, 10...12 = 1381.02 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 18.05 (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 | 1381.02 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 1450.07 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1749.80 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1837.29 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 32.87 | (313) |

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

| | | | | | | |
|---|---|---|---|---|---|---|
| Total electricity for the above, kWh/year | | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | | 333.80 | (332) |
| Total delivered energy for all uses | | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 3621.17 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 1450.07 | x | 4.24 | x 0.01 = | 61.48 | (340a) |
| Water heating from boilers | 1837.29 | x | 4.24 | x 0.01 = | 77.90 | (342a) |
| Electricity for lighting | 333.80 | x | 13.19 | x 0.01 = | 44.03 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 303.41 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.05 | (357) |
| SAP value | 85.37 | |
| 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) = | 3673.03 | x | 0.216 | = | 793.38 | (367) |
| Electrical energy for community heat distribution | | 32.87 | x | 0.519 | = | 17.06 | (372) |
| Total CO2 associated with community systems | | | | | | 810.44 | (373) |
| Total CO2 associated with space and water heating | | | | | | 810.44 | (376) |
| Electricity for lighting | | 333.80 | x | 0.519 | = | 173.24 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 983.68 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 12.86 | (384) |
| EI value | | | | | | 89.15 | |
| EI rating (section 14) | | | | | | 89 | (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) = | 3673.03 | x | 1.22 | = | 4481.10 | (367) |
| Electrical energy for community heat distribution | | 32.87 | x | 3.07 | = | 100.92 | (372) |
| Total primary energy associated with community systems | | | | | | 4582.02 | (373) |
| Total primary energy associated with space and water heating | | | | | | 4582.02 | (376) |
| Electricity for lighting | | 333.80 | x | 3.07 | = | 1024.77 | (379) |
| Primary energy kWh/year | | | | | | 5606.79 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | | 73.27 | (384) |

# 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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 1 02 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 76.52 | (1a) | x | 2.50 | (2a) | = | 191.30 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 76.52 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 191.30 | (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 | | 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 | 0.35 | 0.37 | (22b) |

Calculate effective air change rate for the applicable case:

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

| | 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 | | | 19.13 | x | 1.33 | = | 25.36 | | | (27) |
| External wall | | | 13.50 | x | 0.18 | = | 2.43 | | | (29a) |
| Party wall | | | 64.09 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 32.63 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 27.79 | (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 | | 4.26 | (36) |
| Total fabric heat loss | (33) + (36) = | 32.05 | (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) | 36.67 | 36.47 | 36.27 | 35.36 | 35.19 | 34.40 | 34.40 | 34.25 | 34.70 | 35.19 | 35.54 | 35.90 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 68.72 | 68.52 | 68.33 | 67.41 | 67.24 | 66.45 | 66.45 | 66.30 | 66.75 | 67.24 | 67.59 | 67.95 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 67.41 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.90 | 0.90 | 0.89 | 0.88 | 0.88 | 0.87 | 0.87 | 0.87 | 0.87 | 0.88 | 0.88 | 0.89 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.88 | (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 | 2.39 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 91.05 | (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) | 100.15 | 96.51 | 92.87 | 89.23 | 85.58 | 81.94 | 81.94 | 85.58 | 89.23 | 92.87 | 96.51 | 100.15 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1092.55 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 148.52 | 129.90 | 134.04 | 116.86 | 112.13 | 96.76 | 89.66 | 102.89 | 104.12 | 121.34 | 132.45 | 143.83 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1432.51 | (45) |
| Distribution loss 0.15 x (45)m | 22.28 | 19.48 | 20.11 | 17.53 | 16.82 | 14.51 | 13.45 | 15.43 | 15.62 | 18.20 | 19.87 | 21.58 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.78 | 154.52 | 161.30 | 143.24 | 139.39 | 123.14 | 116.92 | 130.15 | 130.50 | 148.60 | 158.83 | 171.09 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.78 | 154.52 | 161.30 | 143.24 | 139.39 | 123.14 | 116.92 | 130.15 | 130.50 | 148.60 | 158.83 | 171.09 |

∑(64)1...12 = 1753.47 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 71.19 | 62.89 | 66.38 | 59.96 | 59.09 | 53.28 | 51.62 | 56.02 | 55.72 | 62.15 | 65.14 | 69.63 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.90 | 16.79 | 13.65 | 10.34 | 7.73 | 6.52 | 7.05 | 9.16 | 12.30 | 15.61 | 18.22 | 19.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 212.01 | 214.21 | 208.67 | 196.87 | 181.97 | 167.97 | 158.61 | 156.41 | 161.96 | 173.76 | 188.66 | 202.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | (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) | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | (71) |
| Water heating gains (Table 5) | 95.69 | 93.58 | 89.22 | 83.28 | 79.42 | 74.00 | 69.38 | 75.29 | 77.39 | 83.54 | 90.48 | 93.59 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 388.51 | 386.49 | 373.44 | 352.39 | 331.02 | 310.39 | 296.95 | 302.77 | 313.55 | 334.81 | 359.26 | 377.58 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 15.80 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 177.67 | (79) |
| SouthEast | 0.77 | x | 3.33 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 37.44 | (77) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 215.11 | 366.41 | 501.34 | 621.19 | 695.78 | 690.75 | 665.96 | 610.31 | 542.85 | 404.96 | 257.65 | 184.09 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 603.62 | 752.90 | 874.78 | 973.57 | 1026.80 | 1001.14 | 962.90 | 913.08 | 856.40 | 739.78 | 616.91 | 561.67 | (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) | 0.99 | 0.97 | 0.91 | 0.78 | 0.60 | 0.42 | 0.30 | 0.33 | 0.53 | 0.84 | 0.97 | 0.99 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 20.29 | 20.52 | 20.75 | 20.92 | 20.99 | 21.00 | 21.00 | 21.00 | 20.99 | 20.90 | 20.56 | 20.25 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.17 | 20.17 | 20.17 | 20.18 | 20.19 | 20.19 | 20.19 | 20.20 | 20.19 | 20.19 | 20.18 | 20.18 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.89 | 0.74 | 0.55 | 0.37 | 0.25 | 0.28 | 0.47 | 0.80 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.24 | 19.56 | 19.88 | 20.10 | 20.17 | 20.19 | 20.19 | 20.20 | 20.19 | 20.08 | 19.64 | 19.18 | (90) |

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.60 | 19.89 | 20.18 | 20.39 | 20.46 | 20.47 | 20.47 | 20.47 | 20.47 | 20.36 | 19.96 | 19.55 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.60 | 19.89 | 20.18 | 20.39 | 20.46 | 20.47 | 20.47 | 20.47 | 20.47 | 20.36 | 19.96 | 19.55 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.96 | 0.89 | 0.75 | 0.57 | 0.39 | 0.27 | 0.30 | 0.49 | 0.81 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 595.02 | 719.77 | 776.45 | 727.66 | 580.89 | 389.63 | 257.36 | 270.08 | 422.45 | 596.28 | 593.90 | 556.07 | (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] | 1051.66 | 1027.28 | 934.55 | 774.38 | 588.71 | 390.24 | 257.41 | [illegible] | 425.04 | 656.55 | 869.04 | 1043.04 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 339.74 | 206.65 | 117.63 | 33.64 | 5.82 | 0.00 | 0.00 | 0.00 | 0.00 | 44.84 | 198.10 | 362.31 | |

∑(98)1...5, 10...12 = 1308.72 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 17.10 (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 | 363.36 | 221.01 | 125.81 | 35.98 | 6.22 | 0.00 | 0.00 | 0.00 | 0.00 | 47.96 | 211.87 | 387.49 |

∑(211)1...5, 10...12 = 1399.71 (211)

**Water heating**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Efficiency of water heater | 86.54 | 85.59 | 83.99 | 81.64 | 80.18 | 79.80 | 79.80 | 79.80 | 79.80 | 82.05 | 85.40 | 86.77 | (217) |
| Water heating fuel, kWh/month | 203.11 | 180.53 | 192.05 | 175.46 | 173.85 | 154.31 | 146.52 | 163.09 | 163.53 | 181.11 | 185.98 | 197.19 | |

∑(219a)1...12 = 2116.75 (219)

**Annual totals**

| | |
|---|---|
| Space heating fuel - main system 1 | 1399.71 |
| Water heating fuel | 2116.75 |

| | | | |
|---|---|---|---|
| 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) | | 333.80 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 3925.26 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 1399.71 | x | 3.48 | x 0.01 = | 48.71 | (240) |
| Water heating | 2116.75 | x | 3.48 | x 0.01 = | 73.66 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 333.80 | x | 13.19 | x 0.01 = | 44.03 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 296.29 | (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 | 85.71 | |
| 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 | 1399.71 | x | 0.216 | = | 302.34 | (261) |
| Water heating | 2116.75 | x | 0.216 | = | 457.22 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 759.55 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 333.80 | x | 0.519 | = | 173.24 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 971.72 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 12.70 | (273) |
| EI value | | | | | 89.28 | |
| EI rating (section 14) | | | | | 89 | (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 | 1399.71 | x | 1.22 | = | 1707.64 | (261) |
| Water heating | 2116.75 | x | 1.22 | = | 2582.43 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 4290.07 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 333.80 | x | 3.07 | = | 1024.77 | (268) |
| Primary energy kWh/year | | | | | 5545.09 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 72.47 | (273) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 2 05 above hobby room Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 88.78 | (1a) | x | 2.50 | (2a) | = | 221.95 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 88.78 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 221.95 | (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) = | 0.14 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.34 | (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) = | 0.26 | (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 | 0.33 | 0.32 | 0.32 | 0.29 | 0.28 | 0.25 | 0.25 | 0.24 | 0.26 | 0.28 | 0.29 | 0.31 | (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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (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 | | | 23.79 | x | 1.24 | = | 29.40 | | | (27) |
| Exposed floor | | | 88.78 | x | 0.06 | = | 5.33 | | | (28b |
| External wall | | | 28.81 | x | 0.18 | = | 5.19 | | | (29a) |
| Party wall | | | 32.04 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 16.11 | x | 0.12 | = | 1.93 | | | (30) |
| Total area of external elements ∑A, m² | | | 157.49 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 41.84 | (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 | | 15.04 | (36) |
| Total fabric heat loss | (33) + (36) = | 56.88 | (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) | 40.64 | 40.48 | 40.33 | 39.61 | 39.48 | 38.85 | 38.85 | 38.74 | 39.09 | 39.48 | 39.75 | 40.03 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 97.52 | 97.37 | 97.21 | 96.49 | 96.36 | 95.73 | 95.73 | 95.62 | 95.98 | 96.36 | 96.63 | 96.92 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 96.49 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.10 | 1.10 | 1.09 | 1.09 | 1.09 | 1.08 | 1.08 | 1.08 | 1.08 | 1.09 | 1.09 | 1.09 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.09 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.61 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 96.16 | (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) | 105.77 | 101.92 | 98.08 | 94.23 | 90.39 | 86.54 | 86.54 | 90.39 | 94.23 | 98.08 | 101.92 | 105.77 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1153.87 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 156.86 | 137.19 | 141.56 | 123.42 | 118.42 | 102.19 | 94.69 | 108.66 | 109.96 | 128.15 | 139.88 | 151.91 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1512.90 | (45) |
| Distribution loss 0.15 x (45)m | 23.53 | 20.58 | 21.23 | 18.51 | 17.76 | 15.33 | 14.20 | 16.30 | 16.49 | 19.22 | 20.98 | 22.79 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 183.80 | 161.53 | 168.51 | 149.50 | 145.37 | 128.27 | 121.64 | 135.61 | 136.04 | 155.10 | 165.96 | 178.85 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 183.80 | 161.53 | 168.51 | 149.50 | 145.37 | 128.27 | 121.64 | 135.61 | 136.04 | 155.10 | 165.96 | 178.85 |

∑(64)1...12 = 1830.19 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 73.71 | 65.09 | 68.63 | 61.90 | 60.93 | 54.84 | 53.04 | 57.69 | 57.43 | 64.17 | 67.37 | 72.07 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 21.11 | 18.75 | 15.25 | 11.55 | 8.63 | 7.29 | 7.87 | 10.23 | 13.74 | 17.44 | 20.35 | 21.70 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 236.82 | 239.27 | 233.08 | 219.90 | 203.26 | 187.61 | 177.17 | 174.71 | 180.90 | 194.08 | 210.73 | 226.37 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | (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) | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | (71) |
| Water heating gains (Table 5) | 99.08 | 96.86 | 92.24 | 85.97 | 81.90 | 76.17 | 71.30 | 77.54 | 79.76 | 86.25 | 93.58 | 96.86 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 419.13 | 417.01 | 402.70 | 379.54 | 355.92 | 333.20 | 318.46 | 324.61 | 336.52 | 359.90 | 386.79 | 407.06 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthEast | 0.77 | x | 16.66 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 214.10 | (77) |
| NorthWest | 0.77 | x | 7.13 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 28.10 | (81) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | 242.20 | 421.88 | 602.03 | 787.50 | 919.99 | 930.02 | 889.69 | 788.30 | 665.86 | 472.96 | 291.80 | 206.17 | (83) |
| Total gains - internal and solar (73)m + (83)m | 661.33 | 838.89 | 1004.73 | 1167.04 | 1275.90 | 1263.22 | 1208.16 | 1112.91 | 1002.38 | 832.86 | 678.58 | 613.23 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.94 | 0.84 | 0.67 | 0.48 | 0.35 | 0.39 | 0.63 | 0.91 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.96 | 20.21 | 20.51 | 20.80 | 20.95 | 20.99 | 21.00 | 21.00 | 20.97 | 20.74 | 20.28 | 19.91 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.00 | 20.00 | 20.00 | 20.01 | 20.01 | 20.02 | 20.02 | 20.02 | 20.02 | 20.01 | 20.01 | 20.01 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.93 | 0.80 | 0.61 | 0.41 | 0.27 | 0.31 | 0.55 | 0.87 | 0.98 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.63 | 18.98 | 19.41 | 19.80 | 19.97 | 20.01 | 20.02 | 20.02 | 20.00 | 19.73 | 19.10 | 18.56 | (90) |

Living area fraction — Living area ÷ (4) = 0.44 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.22 | 19.52 | 19.89 | 20.24 | 20.40 | 20.44 | 20.45 | 20.45 | 20.43 | 20.17 | 19.62 | 19.16 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.22 | 19.52 | 19.89 | 20.24 | 20.40 | 20.44 | 20.45 | 20.45 | 20.43 | 20.17 | 19.62 | 19.16 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.97 | 0.93 | 0.81 | 0.63 | 0.44 | 0.30 | 0.35 | 0.59 | 0.88 | 0.98 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 655.38 | 816.28 | 930.85 | 947.62 | 804.50 | 555.33 | 368.07 | 386.28 | 589.38 | 732.97 | 663.89 | 609.32 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1454.91 | 1423.63 | 1301.98 | 1094.21 | 838.46 | 559.54 | 368.55 | 387.22 | 607.07 | 922.52 | 1209.63 | 1449.60 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 594.85 | 408.14 | 276.12 | 105.54 | 25.27 | 0.00 | 0.00 | 0.00 | 0.00 | 141.03 | 392.93 | 625.17 | |

∑(98)1...5, 10...12 = 2569.05 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 28.94 (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 | 2569.05 | | (98) |
| Space heat from boilers | (98) x (304a) x (305) x (306) = | 2697.51 | (307a) |

**Water heating**

| | | | |
|---|---|---|---|
| Annual water heating requirement | 1830.19 | | (64) |
| Water heat from boilers | (64) x (303a) x (305a) x (306) = | 1921.70 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 46.19 | (313) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | | |
| Total electricity for the above, kWh/year | | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | | 372.85 | (332) |
| Total delivered energy for all uses | | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4992.06 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 2697.51 | x | 4.24 | x 0.01 = | 114.37 | (340a) |
| Water heating from boilers | 1921.70 | x | 4.24 | x 0.01 = | 81.48 | (342a) |
| Electricity for lighting | 372.85 | x | 13.19 | x 0.01 = | 49.18 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 365.03 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.15 | (357) |
| SAP value | 84.01 | |
| 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) = | 5161.13 | x | 0.216 | = | 1114.80 | (367) |
| Electrical energy for community heat distribution | | 46.19 | x | 0.519 | = | 23.97 | (372) |
| Total CO2 associated with community systems | | | | | | 1138.78 | (373) |
| Total CO2 associated with space and water heating | | | | | | 1138.78 | (376) |
| Electricity for lighting | | 372.85 | x | 0.519 | = | 193.51 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 1332.29 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 15.01 | (384) |
| EI value | | | | | | 86.66 | |
| 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) = | 5161.13 | x | 1.22 | = | 6296.58 | (367) |
| Electrical energy for community heat distribution | | 46.19 | x | 3.07 | = | 141.81 | (372) |
| Total primary energy associated with community systems | | | | | | 6438.39 | (373) |
| Total primary energy associated with space and water heating | | | | | | 6438.39 | (376) |
| Electricity for lighting | | 372.85 | x | 3.07 | = | 1144.65 | (379) |
| Primary energy kWh/year | | | | | | 7583.03 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | | 85.41 | (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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 2 05 above hobby room Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 88.78 | (1a) | x | 2.50 | (2a) | = | 221.95 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 88.78 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 221.95 | (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) = | 0.14 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.39 | (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) = | 0.30 | (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 | 0.38 | 0.37 | 0.37 | 0.33 | 0.32 | 0.28 | 0.28 | 0.28 | 0.30 | 0.32 | 0.34 | 0.35 | (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 | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (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 | | | 22.19 | x | 1.33 | = | 29.42 | | | (27) |
| Exposed floor | | | 88.78 | x | 0.13 | = | 11.54 | | | (28b |
| External wall | | | 30.40 | x | 0.18 | = | 5.47 | | | (29a) |
| Party wall | | | 32.04 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 16.11 | x | 0.13 | = | 2.09 | | | (30) |
| Total area of external elements ∑A, m² | | | 157.48 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 48.53 | (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 | | 12.21 | (36) |
| Total fabric heat loss | (33) + (36) = | 60.73 | (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) | 41.93 | 41.72 | 41.52 | 40.57 | 40.39 | 39.57 | 39.57 | 39.41 | 39.88 | 40.39 | 40.75 | 41.13 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 102.66 | 102.45 | 102.25 | 101.30 | 101.12 | 100.30 | 100.30 | 100.15 | 100.62 | 101.12 | 101.48 | 101.86 | |

Average = ∑(39)1...12/12 = 101.30 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.16 | 1.15 | 1.15 | 1.14 | 1.14 | 1.13 | 1.13 | 1.13 | 1.13 | 1.14 | 1.14 | 1.15 | |

Average = ∑(40)1...12/12 = 1.14 (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 | 2.61 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 96.16 | (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) | 105.77 | 101.92 | 98.08 | 94.23 | 90.39 | 86.54 | 86.54 | 90.39 | 94.23 | 98.08 | 101.92 | 105.77 | |

∑(44)1...12 = 1153.87 (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) | 156.86 | 137.19 | 141.56 | 123.42 | 118.42 | 102.19 | 94.69 | 108.66 | 109.96 | 128.15 | 139.88 | 151.91 | |

∑(45)1...12 = 1512.90 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 23.53 | 20.58 | 21.23 | 18.51 | 17.76 | 15.33 | 14.20 | 16.30 | 16.49 | 19.22 | 20.98 | 22.79 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 184.12 | 161.81 | 168.82 | 149.80 | 145.68 | 128.57 | 121.95 | 135.92 | 136.34 | 155.41 | 166.27 | 179.17 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 184.12 | 161.81 | 168.82 | 149.80 | 145.68 | 128.57 | 121.95 | 135.92 | 136.34 | 155.41 | 166.27 | 179.17 | |

∑(64)1...12 = 1833.87 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 73.96 | 65.31 | 68.88 | 62.14 | 61.18 | 55.08 | 53.29 | 57.94 | 57.67 | 64.42 | 67.62 | 72.32 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | 130.43 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 21.11 | 18.75 | 15.25 | 11.55 | 8.63 | 7.29 | 7.87 | 10.23 | 13.74 | 17.44 | 20.35 | 21.70 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 236.82 | 239.27 | 233.08 | 219.90 | 203.26 | 187.61 | 177.17 | [illegible] | 180.90 | 194.08 | 210.73 | 226.37 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | 36.04 | (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) | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | -104.35 | (71) |
| Water heating gains (Table 5) | 99.41 | 97.19 | 92.58 | 86.31 | 82.24 | 76.50 | 71.63 | 77.87 | 80.09 | 86.58 | 93.91 | 97.20 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 422.47 | 420.34 | 406.04 | 382.88 | 359.25 | 336.53 | 321.80 | 327.95 | 339.86 | 363.24 | 390.12 | 410.40 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthEast | 0.77 | x | 15.54 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 174.74 | (77) |
| NorthWest | 0.77 | x | 6.65 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 22.93 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 197.67 | 344.33 | 491.35 | 642.72 | 750.85 | 759.04 | 726.13 | 643.38 | 543.45 | 386.01 | 238.15 | 168.27 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 620.14 | 764.67 | 897.39 | 1025.60 | 1110.11 | 1095.57 | 1047.93 | 971.32 | 883.30 | 749.25 | 628.28 | 578.66 | (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 | 0.76 | 0.57 | 0.42 | 0.47 | 0.72 | 0.94 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.84 | 20.06 | 20.35 | 20.68 | 20.90 | 20.98 | 21.00 | 20.99 | 20.94 | 20.63 | 20.17 | 19.80 | (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 | 19.97 | 19.97 | 19.97 | 19.96 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.96 | 0.87 | 0.70 | 0.49 | 0.32 | 0.37 | 0.64 | 0.92 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.42 | 18.73 | 19.16 | 19.61 | 19.88 | 19.96 | 19.98 | 19.98 | 19.93 | 19.56 | 18.90 | 18.37 | (90) |

Living area fraction — Living area ÷ (4) = 0.44 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.05 | 19.32 | 19.68 | 20.08 | 20.32 | 20.41 | 20.42 | 20.42 | 20.37 | 20.03 | 19.46 | 19.00 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.05 | 19.32 | 19.68 | 20.08 | 20.32 | 20.41 | 20.42 | 20.42 | 20.37 | 20.03 | 19.46 | 19.00 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.98 | 0.95 | 0.87 | 0.72 | 0.52 | 0.36 | 0.41 | 0.67 | 0.92 | 0.98 | 1.00 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 615.91 | 750.79 | 854.78 | 895.80 | 800.49 | 571.75 | 382.17 | 400.32 | 593.82 | 687.72 | 618.57 | 575.78 | (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] | 1513.87 | 1476.92 | 1347.77 | 1132.69 | 872.20 | 582.92 | [illegible] | 402.98 | 631.33 | 954.00 | 1254.12 | 1507.25 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 668.08 | 487.95 | 366.79 | 170.56 | 53.35 | 0.00 | 0.00 | 0.00 | 0.00 | 198.11 | 457.59 | 693.01 | (98) |

∑(98)1...5, 10...12 = 3095.44 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 34.87 (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 | 714.53 | 521.88 | 392.28 | 182.42 | 57.06 | 0.00 | 0.00 | 0.00 | 0.00 | 211.88 | 489.40 | 741.19 | |

∑(211)1...5, 10...12 = 3310.63 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.95 | 87.58 | 86.83 | 85.16 | 82.41 | 79.80 | 79.80 | 79.80 | 79.80 | 85.46 | 87.38 | 88.07 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 209.34 | 184.76 | 194.43 | 175.90 | 176.78 | 161.12 | 152.83 | 170.33 | 170.85 | 181.85 | 190.28 | 203.43 |

∑(219a)1...12 = 2171.89 (219)

**Annual totals**

| | | | |
|---|---|---|---|
| Space heating fuel - main system 1 | | 3310.63 | |
| Water heating fuel | | 2171.89 | |
| 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) | | 372.85 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 5930.38 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3310.63 | x | 3.48 | x 0.01 = | 115.21 | (240) |
| Water heating | 2171.89 | x | 3.48 | x 0.01 = | 75.58 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 372.85 | x | 13.19 | x 0.01 = | 49.18 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 369.86 | (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 | 83.80 | |
| 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 | 3310.63 | x | 0.216 | = | 715.10 | (261) |
| Water heating | 2171.89 | x | 0.216 | = | 469.13 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 1184.23 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 372.85 | x | 0.519 | = | 193.51 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1416.66 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 15.96 | (273) |
| EI value | | | | | 85.81 | |
| 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 | 3310.63 | x | 1.22 | = | 4038.97 | (261) |
| Water heating | 2171.89 | x | 1.22 | = | 2649.71 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 6688.68 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 372.85 | x | 3.07 | = | 1144.65 | (268) |
| Primary energy kWh/year | | | | | 8063.58 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 90.83 | (273) |

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 4 01 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.40 | (1a) | x | 2.50 | (2a) | = | 186.00 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.40 | (4) | | | | | | |
| Dwelling volume | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | 186.00 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.36 | (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) = | 0.28 | (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 | 0.36 | 0.35 | 0.34 | 0.31 | 0.30 | 0.27 | 0.27 | 0.26 | 0.28 | 0.30 | 0.32 | 0.33 | (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 | 0.56 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.55 | (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 | | | 30.15 | x | 1.24 | = | 37.26 | | | (27) |
| External wall | | | 37.21 | x | 0.18 | = | 6.70 | | | (29a) |
| Party wall | | | 47.00 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 24.36 | x | 0.12 | = | 2.92 | | | (30) |
| Total area of external elements ∑A, m² | | | 91.72 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 46.88 | (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 | | 15.59 | (36) |
| Total fabric heat loss | (33) + (36) = | 62.47 | (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) | 34.60 | 34.45 | 34.30 | 33.60 | 33.47 | 32.86 | 32.86 | 32.75 | 33.10 | 33.47 | 33.74 | 34.01 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 97.07 | 96.92 | 96.77 | 96.07 | 95.94 | 95.33 | 95.33 | 95.21 | 95.56 | 95.94 | 96.20 | 96.48 | |

Average = ∑(39)1...12/12 = 96.07 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.30 | 1.30 | 1.30 | 1.29 | 1.29 | 1.28 | 1.28 | 1.28 | 1.28 | 1.29 | 1.29 | 1.30 | |

Average = ∑(40)1...12/12 = 1.29 (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 | 2.35 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.97 | (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) | 98.96 | 95.36 | 91.77 | 88.17 | 84.57 | 80.97 | 80.97 | 84.57 | 88.17 | 91.77 | 95.36 | 98.96 | |

∑(44)1...12 = 1079.59 (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) | 146.76 | 128.36 | 132.45 | 115.47 | 110.80 | 95.61 | 88.60 | 101.67 | 102.88 | 119.90 | 130.88 | 142.13 | |

∑(45)1...12 = 1415.52 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 22.01 | 19.25 | 19.87 | 17.32 | 16.62 | 14.34 | 13.29 | 15.25 | 15.43 | 17.99 | 19.63 | 21.32 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 | |

∑(64)1...12 = 1732.81 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.36 | 62.15 | 65.60 | 59.26 | 58.40 | 52.65 | 51.02 | 55.36 | 55.07 | 61.43 | 64.38 | 68.82 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | | | | | | | | | | | | | |
| | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 18.48 | 16.42 | 13.35 | 10.11 | 7.56 | 6.38 | 6.89 | 8.96 | 12.03 | 15.27 | 17.82 | 19.00 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 207.34 | 209.49 | 204.07 | 192.53 | 177.96 | 164.26 | 155.12 | 152.96 | 158.39 | 169.93 | 184.50 | 198.19 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | (69) |
| Pump and fan gains (Table 5a) | | | | | | | | | | | | | |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | | | | | | | | | | | | | |
| | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 94.56 | 92.49 | 88.17 | 82.30 | 78.49 | 73.13 | 68.57 | 74.41 | 76.49 | 82.56 | 89.42 | 92.49 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | | | | | | | | | | | | | |
| | 378.61 | 376.62 | 363.81 | 343.16 | 322.23 | 302.00 | 288.80 | 294.56 | 305.12 | 325.98 | 349.96 | 367.91 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.68 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 214.36 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |
| NorthWest | 0.77 | x | 10.00 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 39.41 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 298.36 | 521.30 | 748.04 | 985.13 | 1156.62 | 1171.66 | 1119.87 | 988.35 | 829.58 | 585.52 | 359.75 | 253.79 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 676.97 | 897.92 | 1111.85 | 1328.29 | 1478.85 | 1473.65 | 1408.67 | 1282.91 | 1134.70 | 911.50 | 709.71 | 621.70 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.90 | 0.76 | 0.58 | 0.41 | 0.30 | 0.34 | 0.56 | 0.86 | 0.97 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.83 | 20.15 | 20.51 | 20.82 | 20.95 | 20.99 | 21.00 | 21.00 | 20.97 | 20.73 | 20.20 | 19.77 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.84 | 19.84 | 19.84 | 19.85 | 19.85 | 19.86 | 19.86 | 19.86 | 19.85 | 19.85 | 19.85 | 19.84 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.95 | 0.88 | 0.71 | 0.51 | 0.34 | 0.22 | 0.26 | 0.48 | 0.81 | 0.96 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.32 | 18.77 | 19.27 | 19.66 | 19.81 | 19.85 | 19.86 | 19.86 | 19.83 | 19.58 | 18.87 | 18.23 | (90) |

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.86 | 19.26 | 19.71 | 20.07 | 20.22 | 20.26 | 20.26 | 20.26 | 20.24 | 19.99 | 19.34 | 18.78 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.86 | 19.26 | 19.71 | 20.07 | 20.22 | 20.26 | 20.26 | 20.26 | 20.24 | 19.99 | 19.34 | 18.78 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | | | | | | | | | | | | | |
| | 0.98 | 0.95 | 0.87 | 0.72 | 0.54 | 0.36 | 0.25 | 0.29 | 0.50 | 0.82 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | | |
| | 664.36 | 850.48 | 969.79 | 961.89 | 792.31 | 535.96 | 348.65 | 366.89 | 572.68 | 744.02 | 680.26 | 613.29 | (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] | | | | | | | | | | | | | |
| | 1413.37 | 1391.96 | 1278.21 | 1073.28 | 817.24 | 539.28 | 349.07 | 367.71 | 586.61 | 900.84 | 1177.92 | 1406.50 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | | | | | | | | | | | | | |
| | 557.26 | 363.88 | 229.47 | 80.20 | 18.55 | 0.00 | 0.00 | 0.00 | 0.00 | 116.68 | 358.31 | 590.14 | |

∑(98)1...5, 10...12 = 2314.49 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 31.11 (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 | 2314.49 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 2430.22 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1732.81 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1819.45 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 42.50 | (313) |

| | | | | | |
|---|---|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | |
| Total electricity for the above, kWh/year | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | 326.44 | (332) |
| Total delivered energy for all uses | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4576.11 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 2430.22 | x | 4.24 | x 0.01 = | 103.04 | (340a) |
| Water heating from boilers | 1819.45 | x | 4.24 | x 0.01 = | 77.14 | (342a) |
| Electricity for lighting | 326.44 | x | 13.19 | x 0.01 = | 43.06 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 343.24 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.21 | (357) |
| SAP value | 83.16 | |
| 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) = | 4748.23 | x | 0.216 | = | 1025.62 | (367) |
| Electrical energy for community heat distribution | | 42.50 | x | 0.519 | = | 22.06 | (372) |
| Total CO2 associated with community systems | | | | | | 1047.67 | (373) |
| Total CO2 associated with space and water heating | | | | | | 1047.67 | (376) |
| Electricity for lighting | | 326.44 | x | 0.519 | = | 169.42 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 1217.10 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 16.36 | (384) |
| EI value | | | | | | 86.34 | |
| 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) = | 4748.23 | x | 1.22 | = | 5792.84 | (367) |
| Electrical energy for community heat distribution | | 42.50 | x | 3.07 | = | 130.46 | (372) |
| Total primary energy associated with community systems | | | | | | 5923.31 | (373) |
| Total primary energy associated with space and water heating | | | | | | 5923.31 | (376) |
| Electricity for lighting | | 326.44 | x | 3.07 | = | 1002.18 | (379) |
| Primary energy kWh/year | | | | | | 6925.49 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | | 93.08 | (384) |

# 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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 4 01 Ingestre Road, London, NW5 1XE | | |

### 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.40 | (1a) | x | 2.50 | (2a) | = | 186.00 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.40 | (4) | | | | | | |
| Dwelling volume | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | 186.00 | (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 | | 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 | 0.41 | 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, 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 | | | 18.60 | x | 1.33 | = | 24.66 | | | (27) |
| External wall | | | 48.77 | x | 0.18 | = | 8.78 | | | (29a) |
| Party wall | | | 47.00 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 24.36 | x | 0.13 | = | 3.17 | | | (30) |
| Total area of external elements ∑A, m² | | | 91.73 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 36.60 | (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 | | 8.66 | (36) |
| Total fabric heat loss | (33) + (36) = | 45.27 | (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) | 35.76 | 35.56 | 35.37 | 34.46 | 34.29 | 33.50 | 33.50 | 33.36 | 33.81 | 34.29 | 34.64 | 34.99 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 81.03 | 80.83 | 80.64 | 79.73 | 79.56 | 78.77 | 78.77 | 78.63 | 79.08 | 79.56 | 79.91 | 80.26 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 79.73 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.09 | 1.09 | 1.08 | 1.07 | 1.07 | 1.06 | 1.06 | 1.06 | 1.06 | 1.07 | 1.07 | 1.08 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.07 | (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 | 2.35 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.97 | (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) | 98.96 | 95.36 | 91.77 | 88.17 | 84.57 | 80.97 | 80.97 | 84.57 | 88.17 | 91.77 | 95.36 | 98.96 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1079.59 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.76 | 128.36 | 132.45 | 115.47 | 110.80 | 95.61 | 88.60 | 101.67 | 102.88 | 119.90 | 130.88 | 142.13 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1415.52 | (45) |
| Distribution loss 0.15 x (45)m | 22.01 | 19.25 | 19.87 | 17.32 | 16.62 | 14.34 | 13.29 | 15.25 | 15.43 | 17.99 | 19.63 | 21.32 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 174.02 | 152.98 | 159.71 | 141.86 | 138.06 | 121.99 | 115.86 | 128.93 | 129.26 | 147.16 | 157.26 | 169.39 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 174.02 | 152.98 | 159.71 | 141.86 | 138.06 | 121.99 | 115.86 | 128.93 | 129.26 | 147.16 | 157.26 | 169.39 | |

∑(64)1...12 = 1736.48 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.61 | 62.38 | 65.85 | 59.50 | 58.65 | 52.90 | 51.27 | 55.61 | 55.31 | 61.68 | 64.62 | 69.07 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.48 | 16.42 | 13.35 | 10.11 | 7.56 | 6.38 | 6.89 | 8.96 | 12.03 | 15.27 | 17.82 | 19.00 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 207.34 | 209.49 | 204.07 | 192.53 | 177.96 | 164.26 | 155.12 | 152.96 | 158.39 | 169.93 | 184.50 | 198.19 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | (69) |
| Pump and fan gains (Table 5a) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |
| Losses e.g. evaporation (Table 5) | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | (71) |
| Water heating gains (Table 5) | 94.90 | 92.82 | 88.51 | 82.64 | 78.83 | 73.47 | 68.91 | 74.75 | 76.82 | 82.90 | 89.75 | 92.83 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 381.95 | 379.95 | 367.15 | 346.50 | 325.56 | 305.33 | 292.14 | 297.89 | 308.46 | 329.31 | 353.29 | 371.24 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 10.29 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 115.71 | (79) |
| SouthEast | 0.77 | x | 2.14 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 24.06 | (77) |
| NorthWest | 0.77 | x | 6.17 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 21.28 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 161.05 | 281.39 | 403.78 | 531.77 | 624.34 | 632.46 | 604.50 | 533.50 | 447.80 | 316.06 | 194.18 | 136.99 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 542.99 | 661.34 | 770.93 | 878.26 | 949.90 | 937.79 | 896.64 | 831.40 | 756.25 | 645.37 | 547.48 | 508.23 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 0.99 | 0.96 | 0.88 | 0.72 | 0.53 | 0.39 | 0.43 | 0.68 | 0.93 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.96 | 20.17 | 20.45 | 20.75 | 20.93 | 20.99 | 21.00 | 21.00 | 20.96 | 20.71 | 20.27 | 19.92 | (87) |

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

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

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.95 | 0.85 | 0.66 | 0.45 | 0.30 | 0.34 | 0.60 | 0.90 | 0.98 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.64 | 18.94 | 19.34 | 19.75 | 19.96 | 20.03 | 20.03 | 20.04 | 20.00 | 19.71 | 19.10 | 18.59 | (90) |

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.11 | 19.38 | 19.74 | 20.11 | 20.31 | 20.37 | 20.38 | 20.38 | 20.34 | 20.06 | 19.51 | 19.06 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.11 | 19.38 | 19.74 | 20.11 | 20.31 | 20.37 | 20.38 | 20.38 | 20.34 | 20.06 | 19.51 | 19.06 | (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 | 0.94 | 0.85 | 0.68 | 0.48 | 0.33 | 0.37 | 0.63 | 0.90 | 0.98 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 538.34 | 646.65 | 726.63 | 745.66 | 646.62 | 449.68 | 297.00 | 311.70 | 475.07 | 580.26 | 536.78 | 505.02 | (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] | 1199.96 | 1170.30 | 1067.28 | 893.72 | 684.87 | 454.51 | 297.33 | 312.72 | 493.79 | 752.78 | 991.92 | 1192.92 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 492.25 | 351.90 | 253.44 | 106.60 | 28.46 | 0.00 | 0.00 | 0.00 | 0.00 | 128.36 | 327.70 | 511.80 | |

∑(98)1...5, 10...12 = 2200.50 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 29.58 (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 | 526.47 | 376.36 | 271.06 | 114.01 | 30.44 | 0.00 | 0.00 | 0.00 | 0.00 | 137.28 | 350.48 | 547.38 | |

∑(211)1...5, 10...12 = 2353.48 (211)

**Water heating**

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Efficiency of water heater | 87.44 | 86.97 | 86.04 | 84.06 | 81.45 | 79.80 | 79.80 | 79.80 | 79.80 | 84.45 | 86.73 | 87.58 | (217) |
| Water heating fuel, kWh/month | 199.02 | 175.90 | 185.62 | 168.75 | 169.51 | 152.87 | 145.19 | 161.57 | 161.98 | 174.25 | 181.33 | 193.41 | |

∑(219a)1...12 = 2069.41 (219)

**Annual totals**

| | | | |
|---|---|---|---|
| Space heating fuel - main system 1 | | 2353.48 | |
| Water heating fuel | | 2069.41 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | (230c) |
| boiler flue fan | 45.00 | | (230e) |
| Total electricity for the above, kWh/year | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | 326.44 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 4824.33 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2353.48 | x | 3.48 | x 0.01 = | 81.90 | (240) |
| Water heating | 2069.41 | x | 3.48 | x 0.01 = | 72.02 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 326.44 | x | 13.19 | x 0.01 = | 43.06 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | (240)...(242) + (245)...(254) = | | 326.87 | (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 | 83.96 | |
| 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 | 2353.48 | x | 0.216 | = | 508.35 | (261) |
| Water heating | 2069.41 | x | 0.216 | = | 446.99 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 955.34 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 326.44 | x | 0.519 | = | 169.42 | (268) |
| Total $CO_2$, kg/year | | | (265)...(271) = | | 1163.69 | (272) |
| Dwelling $CO_2$ emission rate | | | (272) ÷ (4) = | | 15.64 | (273) |
| EI value | | | | | 86.94 | |
| 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 | 2353.48 | x | 1.22 | = | 2871.24 | (261) |
| Water heating | 2069.41 | x | 1.22 | = | 2524.68 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 5395.92 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 326.44 | x | 3.07 | = | 1002.18 | (268) |
| Primary energy kWh/year | | | | | 6628.35 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 89.09 | (273) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 4 02 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area ($m^2$) | | | Average storey height (m) | | | Volume ($m^3$) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 76.52 | (1a) | x | 2.50 | (2a) | = | 191.30 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 76.52 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 191.30 | (5) |

## 2. Ventilation rate

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

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

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.36 | (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) = | 0.28 | (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 | 0.35 | 0.35 | 0.34 | 0.30 | 0.30 | 0.26 | 0.26 | 0.26 | 0.28 | 0.30 | 0.31 | 0.32 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (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 | | | 19.92 | x | 1.24 | = | 24.62 | | | (27) |
| External wall | | | 12.70 | x | 0.18 | = | 2.29 | | | (29a) |
| Party wall | | | 64.09 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 9.65 | x | 0.12 | = | 1.16 | | | (30) |
| Total area of external elements ∑A, m² | | | 42.27 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 28.06 | (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 | | 10.11 | (36) |
| Total fabric heat loss | (33) + (36) = | 38.17 | (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) | 35.49 | 35.34 | 35.19 | 34.49 | 34.35 | 33.74 | 33.74 | 33.63 | 33.98 | 34.35 | 34.62 | 34.90 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 73.66 | 73.50 | 73.35 | 72.65 | 72.52 | 71.91 | 71.91 | 71.80 | 72.15 | 72.52 | 72.79 | 73.06 | |

Average = ∑(39)1...12/12 = 72.65 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.96 | 0.96 | 0.96 | 0.95 | 0.95 | 0.94 | 0.94 | 0.94 | 0.94 | 0.95 | 0.95 | 0.95 | |

Average = ∑(40)1...12/12 = 0.95 (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 | 2.39 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 91.05 | (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) | 100.15 | 96.51 | 92.87 | 89.23 | 85.58 | 81.94 | 81.94 | 85.58 | 89.23 | 92.87 | 96.51 | 100.15 | |

∑(44)1...12 = 1092.55 (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) | 148.52 | 129.90 | 134.04 | 116.86 | 112.13 | 96.76 | 89.66 | 102.89 | 104.12 | 121.34 | 132.45 | 143.83 | |

∑(45)1...12 = 1432.51 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 22.28 | 19.48 | 20.11 | 17.53 | 16.82 | 14.51 | 13.45 | 15.43 | 15.62 | 18.20 | 19.87 | 21.58 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 |

∑(64)1...12 = 1749.80 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.94 | 62.66 | 66.13 | 59.72 | 58.84 | 53.04 | 51.37 | 55.77 | 55.48 | 61.90 | 64.90 | 69.38 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.90 | 16.79 | 13.65 | 10.34 | 7.73 | 6.52 | 7.05 | 9.16 | 12.30 | 15.61 | 18.22 | 19.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 212.01 | 214.21 | 208.67 | 196.87 | 181.97 | 167.97 | 158.61 | 156.41 | 161.96 | 173.76 | 188.66 | 202.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | (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) | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | (71) |
| Water heating gains (Table 5) | 95.35 | 93.25 | 88.88 | 82.94 | 79.09 | 73.66 | 69.05 | 74.96 | 77.06 | 83.20 | 90.14 | 93.26 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 385.17 | 383.15 | 370.11 | 349.05 | 327.69 | 307.05 | 293.61 | 299.43 | 310.21 | 331.48 | 355.93 | 374.25 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.45 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 211.40 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 255.99 | 436.05 | 596.62 | 739.25 | 828.02 | 822.03 | 792.52 | 726.30 | 646.02 | 481.93 | 306.62 | 219.08 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 641.16 | 819.20 | 966.73 | 1088.30 | 1155.70 | 1129.08 | 1086.13 | 1025.73 | 956.23 | 813.41 | 662.55 | 593.32 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.89 | 0.75 | 0.57 | 0.41 | 0.29 | 0.32 | 0.52 | 0.82 | 0.97 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.24 | 20.50 | 20.74 | 20.92 | 20.98 | 21.00 | 21.00 | 21.00 | 20.99 | 20.89 | 20.53 | 20.19 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.11 | 20.12 | 20.12 | 20.13 | 20.13 | 20.13 | 20.13 | 20.14 | 20.13 | 20.13 | 20.12 | 20.12 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.95 | 0.87 | 0.71 | 0.52 | 0.35 | 0.23 | 0.26 | 0.45 | 0.78 | 0.96 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.12 | 19.48 | 19.82 | 20.04 | 20.11 | 20.13 | 20.13 | 20.13 | 20.13 | 20.02 | 19.54 | 19.05 | (90) |

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.51 | 19.83 | 20.14 | 20.35 | 20.42 | 20.43 | 20.43 | 20.43 | 20.43 | 20.32 | 19.88 | 19.44 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.51 | 19.83 | 20.14 | 20.35 | 20.42 | 20.43 | 20.43 | 20.43 | 20.43 | 20.32 | 19.88 | 19.44 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.98 | 0.95 | 0.87 | 0.72 | 0.54 | 0.37 | 0.25 | 0.28 | 0.47 | 0.79 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 630.21 | 775.40 | 838.94 | 783.79 | 623.75 | 418.71 | 275.65 | 289.58 | 453.47 | 640.29 | 633.74 | 586.26 | (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] | 1120.40 | 1097.74 | 1000.49 | 831.74 | 632.10 | 419.45 | 275.71 | 289.69 | 456.50 | 704.87 | 930.55 | 1113.74 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 364.70 | 216.61 | 120.19 | 34.52 | 6.21 | 0.00 | 0.00 | 0.00 | 0.00 | 48.05 | 213.70 | 392.45 | |

∑(98)1...5, 10...12 = 1396.43 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 18.25 (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 | 1396.43 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 1466.26 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1749.80 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1837.29 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 33.04 | (313) |

| | | | | | |
|---|---|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | |
| Total electricity for the above, kWh/year | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | 333.80 | (332) |
| Total delivered energy for all uses | | | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 3637.35 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 1466.26 | x | 4.24 | x 0.01 = | 62.17 | (340a) |
| Water heating from boilers | 1837.29 | x | 4.24 | x 0.01 = | 77.90 | (342a) |
| Electricity for lighting | 333.80 | x | 13.19 | x 0.01 = | 44.03 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 304.10 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.05 | (357) |
| SAP value | 85.34 | |
| 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) = | 3691.11 | x | 0.216 | = | 797.28 | (367) |
| Electrical energy for community heat distribution | | 33.04 | x | 0.519 | = | 17.15 | (372) |
| Total CO2 associated with community systems | | | | | | 814.43 | (373) |
| Total CO2 associated with space and water heating | | | | | | 814.43 | (376) |
| Electricity for lighting | | 333.80 | x | 0.519 | = | 173.24 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 987.67 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 12.91 | (384) |
| EI value | | | | | | 89.11 | |
| EI rating (section 14) | | | | | | 89 | (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) = | 3691.11 | x | 1.22 | = | 4503.16 | (367) |
| Electrical energy for community heat distribution | | 33.04 | x | 3.07 | = | 101.42 | (372) |
| Total primary energy associated with community systems | | | | | | 4604.58 | (373) |
| Total primary energy associated with space and water heating | | | | | | 4604.58 | (376) |
| Electricity for lighting | | 333.80 | x | 3.07 | = | 1024.77 | (379) |
| Primary energy kWh/year | | | | | | 5629.35 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | | 73.57 | (384) |

# 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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 4 02 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 76.52 | (1a) | x | 2.50 | (2a) | = | 191.30 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 76.52 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 191.30 | (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 | | 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 | 0.35 | 0.37 | (22b) |

Calculate effective air change rate for the applicable case:

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

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

| | 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 | | | 19.13 | x | 1.33 | = | 25.36 | | | (27) |
| External wall | | | 13.50 | x | 0.18 | = | 2.43 | | | (29a) |
| Party wall | | | 64.09 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 9.65 | x | 0.13 | = | 1.25 | | | (30) |
| Total area of external elements ∑A, m² | | | 42.28 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 29.05 | (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 | | 7.06 | (36) |
| Total fabric heat loss | (33) + (36) = | 36.11 | (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) | 36.67 | 36.47 | 36.27 | 35.36 | 35.19 | 34.40 | 34.40 | 34.25 | 34.70 | 35.19 | 35.54 | 35.90 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 72.77 | 72.58 | 72.38 | 71.47 | 71.30 | 70.51 | 70.51 | 70.36 | 70.81 | 71.30 | 71.64 | 72.01 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 71.47 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 0.95 | 0.95 | 0.95 | 0.93 | 0.93 | 0.92 | 0.92 | 0.92 | 0.93 | 0.93 | 0.94 | 0.94 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 0.93 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.39 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 91.05 | (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) | 100.15 | 96.51 | 92.87 | 89.23 | 85.58 | 81.94 | 81.94 | 85.58 | 89.23 | 92.87 | 96.51 | 100.15 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1092.55 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 148.52 | 129.90 | 134.04 | 116.86 | 112.13 | 96.76 | 89.66 | 102.89 | 104.12 | 121.34 | 132.45 | 143.83 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1432.51 | (45) |
| Distribution loss 0.15 x (45)m | 22.28 | 19.48 | 20.11 | 17.53 | 16.82 | 14.51 | 13.45 | 15.43 | 15.62 | 18.20 | 19.87 | 21.58 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.78 | 154.52 | 161.30 | 143.24 | 139.39 | 123.14 | 116.92 | 130.15 | 130.50 | 148.60 | 158.83 | 171.09 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.78 | 154.52 | 161.30 | 143.24 | 139.39 | 123.14 | 116.92 | 130.15 | 130.50 | 148.60 | 158.83 | 171.09 |

∑(64)1...12 = 1753.47 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 71.19 | 62.89 | 66.38 | 59.96 | 59.09 | 53.28 | 51.62 | 56.02 | 55.72 | 62.15 | 65.14 | 69.63 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.90 | 16.79 | 13.65 | 10.34 | 7.73 | 6.52 | 7.05 | 9.16 | 12.30 | 15.61 | 18.22 | 19.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 212.01 | 214.21 | 208.67 | 196.87 | 181.97 | 167.97 | 158.61 | 156.41 | 161.96 | 173.76 | 188.66 | 202.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | (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) | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | (71) |
| Water heating gains (Table 5) | 95.69 | 93.58 | 89.22 | 83.28 | 79.42 | 74.00 | 69.38 | 75.29 | 77.39 | 83.54 | 90.48 | 93.59 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 388.51 | 386.49 | 373.44 | 352.39 | 331.02 | 310.39 | 296.95 | 302.77 | 313.55 | 334.81 | 359.26 | 377.58 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 15.80 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 177.67 | (79) |
| SouthEast | 0.77 | x | 3.33 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 37.44 | (77) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 215.11 | 366.41 | 501.34 | 621.19 | 695.78 | 690.75 | 665.96 | 610.31 | 542.85 | 404.96 | 257.65 | 184.09 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 603.62 | 752.90 | 874.78 | 973.57 | 1026.80 | 1001.14 | 962.90 | 913.08 | 856.40 | 739.78 | 616.91 | 561.67 | (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) | 0.99 | 0.97 | 0.92 | 0.80 | 0.63 | 0.45 | 0.32 | 0.35 | 0.56 | 0.86 | 0.98 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.21 | 20.44 | 20.69 | 20.89 | 20.98 | 21.00 | 21.00 | 21.00 | 20.99 | 20.86 | 20.50 | 20.17 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 20.12 | 20.13 | 20.13 | 20.14 | 20.14 | 20.15 | 20.15 | 20.15 | 20.15 | 20.14 | 20.14 | 20.13 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.90 | 0.76 | 0.58 | 0.39 | 0.26 | 0.29 | 0.50 | 0.82 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.09 | 19.42 | 19.76 | 20.03 | 20.12 | 20.15 | 20.15 | 20.15 | 20.14 | 20.00 | 19.51 | 19.03 | (90) |

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.48 | 19.77 | 20.08 | 20.33 | 20.42 | 20.44 | 20.44 | 20.45 | 20.43 | 20.30 | 19.85 | 19.43 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.48 | 19.77 | 20.08 | 20.33 | 20.42 | 20.44 | 20.44 | 20.45 | 20.43 | 20.30 | 19.85 | 19.43 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.96 | 0.90 | 0.77 | 0.59 | 0.41 | 0.28 | 0.31 | 0.52 | 0.83 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 595.60 | 723.03 | 787.14 | 751.14 | 608.93 | 410.77 | 270.94 | 284.44 | 444.12 | 611.14 | 596.15 | 556.39 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1104.72 | 1079.52 | 983.02 | 816.60 | 621.57 | 411.93 | 271.04 | 284.61 | 448.58 | 691.57 | 913.59 | 1096.32 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 378.79 | 239.56 | 145.74 | 47.13 | 9.41 | 0.00 | 0.00 | 0.00 | 0.00 | 59.85 | 228.56 | 401.71 | |

∑(98)1...5, 10...12 = 1510.73 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 19.74 (99)

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

**Space heating**

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Space heating fuel (main system 1), kWh/month | 405.12 | 256.21 | 155.87 | 50.41 | 10.06 | 0.00 | 0.00 | 0.00 | 0.00 | 64.01 | 244.45 | 429.63 | |

∑(211)1...5, 10...12 = 1615.76 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 86.81 | 85.98 | 84.54 | 82.21 | 80.40 | 79.80 | 79.80 | 79.80 | 79.80 | 82.60 | 85.78 | 87.01 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 202.49 | 179.72 | 190.79 | 174.25 | 173.37 | 154.31 | 146.52 | 163.09 | 163.53 | 179.89 | 185.15 | 196.63 |

∑(219a)1...12 = 2109.74 (219)

**Annual totals**

Space heating fuel - main system 1 — 1615.76

| | | | | |
|---|---|---|---|---|
| Water heating fuel | | | 2109.74 | |
| 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) | | | 333.80 | (232) |
| Total delivered energy for all uses | | (211)...(221) + (231) + (232)...(237b) = | 4134.30 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 1615.76 | x | 3.48 | x 0.01 = | 56.23 | (240) |
| Water heating | 2109.74 | x | 3.48 | x 0.01 = | 73.42 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 333.80 | x | 13.19 | x 0.01 = | 44.03 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 303.57 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.05 | (257) |
| SAP value | 85.36 | |
| SAP rating (section 13) | 85 | (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 | 1615.76 | x | 0.216 | = | 349.00 | (261) |
| Water heating | 2109.74 | x | 0.216 | = | 455.70 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 804.71 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 333.80 | x | 0.519 | = | 173.24 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1016.88 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 13.29 | (273) |
| EI value | | | | | 88.79 | |
| EI rating (section 14) | | | | | 89 | (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 | 1615.76 | x | 1.22 | = | 1971.22 | (261) |
| Water heating | 2109.74 | x | 1.22 | = | 2573.89 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 4545.11 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 333.80 | x | 3.07 | = | 1024.77 | (268) |
| Primary energy kWh/year | | | | | 5800.13 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 75.80 | (273) |

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 5 01 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 86.50 | (1a) | x | 2.50 | (2a) | = | 216.25 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 86.50 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 216.25 | (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) = | 0.14 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.34 | (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) = | 0.26 | (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 | 0.33 | 0.33 | 0.32 | 0.29 | 0.28 | 0.25 | 0.25 | 0.24 | 0.26 | 0.28 | 0.30 | 0.31 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d) | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (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 | | | 29.06 | x | 1.24 | = | 35.91 | | | (27) |
| External wall | | | 25.62 | x | 0.18 | = | 4.61 | | | (29a) |
| Party wall | | | 54.80 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 86.50 | x | 0.12 | = | 10.38 | | | (30) |
| Total area of external elements ∑A, m² | | | 141.18 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 50.90 | (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 | | 21.37 | (36) |
| Total fabric heat loss | (33) + (36) = | 72.27 | (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) | 39.68 | 39.52 | 39.37 | 38.66 | 38.52 | 37.90 | 37.90 | 37.79 | 38.14 | 38.52 | 38.79 | 39.08 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 111.95 | 111.79 | 111.64 | 110.93 | 110.79 | 110.17 | 110.17 | 110.06 | 110.41 | 110.79 | 111.06 | 111.35 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 110.93 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.29 | 1.29 | 1.29 | 1.28 | 1.28 | 1.27 | 1.27 | 1.27 | 1.28 | 1.28 | 1.28 | 1.29 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.28 | (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 | 2.57 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 95.35 | (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) | 104.88 | 101.07 | 97.26 | 93.44 | 89.63 | 85.81 | 85.81 | 89.63 | 93.44 | 97.26 | 101.07 | 104.88 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1144.20 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 155.54 | 136.04 | 140.38 | 122.38 | 117.43 | 101.33 | 93.90 | 107.75 | 109.04 | 127.08 | 138.71 | 150.63 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1500.22 | (45) |
| Distribution loss 0.15 x (45)m | 23.33 | 20.41 | 21.06 | 18.36 | 17.61 | 15.20 | 14.09 | 16.16 | 16.36 | 19.06 | 20.81 | 22.59 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 182.49 | 160.38 | 167.33 | 148.46 | 144.38 | 127.41 | 120.85 | 134.70 | 135.12 | 154.02 | 164.79 | 177.58 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 182.49 | 160.38 | 167.33 | 148.46 | 144.38 | 127.41 | 120.85 | 134.70 | 135.12 | 154.02 | 164.79 | 177.58 |

∑(64)1...12 = 1817.51 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 73.28 | 64.70 | 68.23 | 61.56 | 60.60 | 54.56 | 52.78 | 57.39 | 57.12 | 63.81 | 66.99 | 71.64 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | | | | | | | | | | | | | |
| | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 20.73 | 18.41 | 14.97 | 11.33 | 8.47 | 7.15 | 7.73 | 10.05 | 13.48 | 17.12 | 19.98 | 21.30 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 232.49 | 234.90 | 228.82 | 215.88 | 199.54 | 184.19 | 173.93 | 171.52 | 177.60 | 190.54 | 206.88 | 222.23 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | (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) | | | | | | | | | | | | | |
| | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 98.49 | 96.29 | 91.71 | 85.49 | 81.46 | 75.77 | 70.94 | 77.13 | 79.33 | 85.77 | 93.03 | 96.30 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | | | | | | | | | | | | | |
| | 413.33 | 411.22 | 397.13 | 374.33 | 351.09 | 328.73 | 314.22 | 320.32 | 332.03 | 355.05 | 381.51 | 401.45 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 23.26 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 298.92 | (79) |
| NorthWest | 0.77 | x | 5.80 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 22.86 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 321.77 | 555.69 | 780.48 | 1000.86 | 1151.90 | 1157.14 | 1109.96 | 995.20 | 856.48 | 619.59 | 386.79 | 274.48 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 735.10 | 966.91 | 1177.61 | 1375.19 | 1502.99 | 1485.87 | 1424.18 | 1315.52 | 1188.51 | 974.64 | 768.31 | 675.93 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.97 | 0.92 | 0.81 | 0.64 | 0.47 | 0.34 | 0.38 | 0.61 | 0.88 | 0.98 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.79 | 20.09 | 20.44 | 20.76 | 20.93 | 20.99 | 21.00 | 21.00 | 20.96 | 20.69 | 20.16 | 19.73 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.85 | 19.85 | 19.85 | 19.85 | 19.86 | 19.86 | 19.86 | 19.86 | 19.86 | 19.86 | 19.85 | 19.85 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.90 | 0.77 | 0.58 | 0.39 | 0.25 | 0.29 | 0.52 | 0.84 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.27 | 18.70 | 19.19 | 19.61 | 19.80 | 19.85 | 19.86 | 19.86 | 19.83 | 19.54 | 18.81 | 18.19 | (90) |

Living area fraction — Living area ÷ (4) = 0.57 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.14 | 19.49 | 19.90 | 20.26 | 20.44 | 20.50 | 20.51 | 20.51 | 20.47 | 20.19 | 19.58 | 19.06 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.14 | 19.49 | 19.90 | 20.26 | 20.44 | 20.50 | 20.51 | 20.51 | 20.47 | 20.19 | 19.58 | 19.06 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.96 | 0.90 | 0.78 | 0.61 | 0.43 | 0.30 | 0.34 | 0.57 | 0.86 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 725.18 | 929.01 | 1064.16 | 1078.40 | 919.11 | 641.88 | 429.30 | 449.85 | 676.92 | 833.87 | 744.83 | 669.36 | (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] | 1661.13 | 1631.19 | 1495.75 | 1260.43 | 968.68 | 649.87 | 430.47 | 451.95 | 703.72 | 1062.90 | 1386.07 | 1655.14 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 696.35 | 471.87 | 321.10 | 131.06 | 36.88 | 0.00 | 0.00 | 0.00 | 0.00 | 170.40 | 461.69 | 733.42 | |

∑(98)1...5, 10...12 = 3022.77 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 34.95 (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 | 3022.77 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 3173.91 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1817.51 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1908.39 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 50.82 | (313) |

| | | | |
|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| Total electricity for the above, kWh/year | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | 366.04 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 5448.33 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 3173.91 | x | 4.24 | x 0.01 = | 134.57 | (340a) |
| Water heating from boilers | 1908.39 | x | 4.24 | x 0.01 = | 80.92 | (342a) |
| Electricity for lighting | 366.04 | x | 13.19 | x 0.01 = | 48.28 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 383.77 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.23 | (357) |
| SAP value | 82.90 | |
| 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) = | 5678.54 | x | 0.216 | = | 1226.57 | (367) |
| Electrical energy for community heat distribution | | 50.82 | x | 0.519 | = | 26.38 | (372) |
| Total CO2 associated with community systems | | | | | | 1252.94 | (373) |
| Total CO2 associated with space and water heating | | | | | | 1252.94 | (376) |
| Electricity for lighting | | 366.04 | x | 0.519 | = | 189.97 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 1442.92 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 16.68 | (384) |
| EI value | | | | | | 85.30 | |
| 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) = | 5678.54 | x | 1.22 | = | 6927.82 | (367) |
| Electrical energy for community heat distribution | | 50.82 | x | 3.07 | = | 156.03 | (372) |
| Total primary energy associated with community systems | | | | | | 7083.85 | (373) |
| Total primary energy associated with space and water heating | | | | | | 7083.85 | (376) |
| Electricity for lighting | | 366.04 | x | 3.07 | = | 1123.74 | (379) |
| Primary energy kWh/year | | | | | | 8207.59 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | | 94.89 | (384) |

# 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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 5 01 Ingestre Road, London, NW5 1XE | | |



## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 86.50 | (1a) | x | 2.50 | (2a) | = | 216.25 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 86.50 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 216.25 | (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) = | 0.14 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.39 | (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) = | 0.30 | (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 | 0.38 | 0.38 | 0.37 | 0.33 | 0.32 | 0.29 | 0.29 | 0.28 | 0.30 | 0.32 | 0.34 | 0.35 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d) | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.55 | 0.55 | 0.56 | 0.56 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.55 | 0.55 | 0.56 | 0.56 | (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 | | | 21.64 | x | 1.33 | = | 28.69 | | | (27) |
| External wall | | | 33.08 | x | 0.18 | = | 5.95 | | | (29a) |
| Party wall | | | 54.80 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 86.50 | x | 0.13 | = | 11.25 | | | (30) |
| Total area of external elements ∑A, m² | | | 141.22 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 45.89 | (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 | | 23.52 | (36) |
| Total fabric heat loss | (33) + (36) = | 69.40 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 40.95 | 40.74 | 40.54 | 39.60 | 39.42 | 38.60 | 38.60 | 38.45 | 38.92 | 39.42 | 39.78 | 40.15 | (38) |

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 110.35 | 110.15 | 109.95 | 109.00 | 108.83 | 108.01 | 108.01 | 107.86 | 108.32 | 108.83 | 109.18 | 109.56 |

Average = ∑(39)1...12/12 = 109.00 (39)

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

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.28 | 1.27 | 1.27 | 1.26 | 1.26 | 1.25 | 1.25 | 1.25 | 1.25 | 1.26 | 1.26 | 1.27 |

Average = ∑(40)1...12/12 = 1.26 (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 | 2.57 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 95.35 | (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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 104.88 | 101.07 | 97.26 | 93.44 | 89.63 | 85.81 | 85.81 | 89.63 | 93.44 | 97.26 | 101.07 | 104.88 |

∑(44)1...12 = 1144.20 (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 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 155.54 | 136.04 | 140.38 | 122.38 | 117.43 | 101.33 | 93.90 | 107.75 | 109.04 | 127.08 | 138.71 | 150.63 |

∑(45)1...12 = 1500.22 (45)

Distribution loss 0.15 x (45)m

| Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 23.33 | 20.41 | 21.06 | 18.36 | 17.61 | 15.20 | 14.09 | 16.16 | 16.36 | 19.06 | 20.81 | 22.59 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 182.80 | 160.66 | 167.64 | 148.77 | 144.69 | 127.72 | 121.16 | 135.01 | 135.42 | 154.34 | 165.09 | 177.89 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 182.80 | 160.66 | 167.64 | 148.77 | 144.69 | 127.72 | 121.16 | 135.01 | 135.42 | 154.34 | 165.09 | 177.89 | (63) |

∑(64)1...12 = 1821.19 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 73.53 | 64.93 | 68.48 | 61.80 | 60.85 | 54.80 | 53.03 | 57.64 | 57.36 | 64.06 | 67.23 | 71.89 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | 128.74 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 20.73 | 18.41 | 14.97 | 11.33 | 8.47 | 7.15 | 7.73 | 10.05 | 13.48 | 17.12 | 19.98 | 21.30 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 232.49 | 234.90 | 228.82 | 215.88 | 199.54 | 184.19 | 173.93 | 171.52 | 177.60 | 190.54 | 206.88 | 222.23 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | 35.87 | (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) | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | -102.99 | (71) |
| Water heating gains (Table 5) | 98.82 | 96.62 | 92.05 | 85.83 | 81.79 | 76.11 | 71.28 | 77.47 | 79.67 | 86.10 | 93.37 | 96.63 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 416.66 | 414.55 | 400.46 | 377.67 | 354.43 | 332.07 | 317.56 | 323.65 | 335.37 | 358.38 | 384.85 | 404.79 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 17.32 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 194.76 | (79) |
| NorthWest | 0.77 | x | 4.32 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 14.90 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 209.65 | 362.07 | 508.54 | 652.13 | 750.55 | 753.97 | 723.22 | 648.45 | 558.05 | 403.70 | 252.02 | 178.84 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 626.32 | 776.62 | 909.00 | 1029.80 | 1104.98 | 1086.04 | 1040.78 | 972.10 | 893.42 | 762.09 | 636.87 | 583.62 | (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 | 0.99 | 0.97 | 0.91 | 0.79 | 0.61 | 0.45 | 0.50 | 0.74 | 0.94 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.71 | 19.93 | 20.24 | 20.59 | 20.85 | 20.97 | 20.99 | 20.99 | 20.91 | 20.56 | 20.06 | 19.66 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.86 | 19.86 | 19.86 | 19.87 | 19.87 | 19.88 | 19.88 | 19.88 | 19.88 | 19.87 | 19.87 | 19.87 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.96 | 0.88 | 0.72 | 0.51 | 0.34 | 0.38 | 0.66 | 0.92 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.16 | 18.49 | 18.93 | 19.42 | 19.74 | 19.86 | 19.88 | 19.88 | 19.82 | 19.39 | 18.68 | 18.10 | (90) |

Living area fraction — Living area ÷ (4) = 0.57 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.04 | 19.31 | 19.67 | 20.09 | 20.37 | 20.49 | 20.51 | 20.51 | 20.44 | 20.06 | 19.46 | 18.99 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.04 | 19.31 | 19.67 | 20.09 | 20.37 | 20.49 | 20.51 | 20.51 | 20.44 | 20.06 | 19.46 | 18.99 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.98 | 0.95 | 0.89 | 0.75 | 0.57 | 0.40 | 0.45 | 0.70 | 0.92 | 0.98 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 621.65 | 761.92 | 867.05 | 911.92 | 832.24 | 613.76 | 418.96 | 437.26 | 627.22 | 702.83 | 626.62 | 580.39 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1626.38 | 1587.02 | 1448.52 | 1219.35 | 943.27 | 636.04 | 422.59 | 443.29 | 686.64 | 1029.01 | 1349.60 | 1620.10 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 747.52 | 554.46 | 432.62 | 221.34 | 82.61 | 0.00 | 0.00 | 0.00 | 0.00 | 242.67 | 520.55 | 773.54 | |

∑(98)1...5, 10...12 = 3575.32 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 41.33 (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 | 799.49 | 593.01 | 462.69 | 236.73 | 88.35 | 0.00 | 0.00 | 0.00 | 0.00 | 259.55 | 556.73 | 827.32 | |

∑(211)1...5, 10...12 = 3823.87 (211)

**Water heating**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Efficiency of water heater | 88.18 | 87.85 | 87.23 | 85.87 | 83.38 | 79.80 | 79.80 | 79.80 | 79.80 | 86.02 | 87.67 | 88.29 | (217) |
| Water heating fuel, kWh/month | 207.31 | 182.87 | 192.17 | 173.24 | 173.53 | 160.04 | 151.83 | 169.19 | 169.70 | 179.43 | 188.31 | 201.49 | |

∑(219a)1...12 = 2149.12 (219)

**Annual totals**

Space heating fuel - main system 1 — 3823.87

| | | | | | |
|---|---|---|---|---|---|
| Water heating fuel | | | | 2149.12 | |
| 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) | | | | 366.04 | (232) |
| Total delivered energy for all uses | | | (211)...(221) + (231) + (232)...(237b) = | 6414.03 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3823.87 | x | 3.48 | x 0.01 = | 133.07 | (240) |
| Water heating | 2149.12 | x | 3.48 | x 0.01 = | 74.79 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 366.04 | x | 13.19 | x 0.01 = | 48.28 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 386.03 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.23 | (257) |
| SAP value | 82.80 | |
| 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 | 3823.87 | x | 0.216 | = | 825.96 | (261) |
| Water heating | 2149.12 | x | 0.216 | = | 464.21 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 1290.17 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 366.04 | x | 0.519 | = | 189.97 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1519.07 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 17.56 | (273) |
| EI value | | | | | 84.52 | |
| 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 | 3823.87 | x | 1.22 | = | 4665.12 | (261) |
| Water heating | 2149.12 | x | 1.22 | = | 2621.93 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 7287.05 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 366.04 | x | 3.07 | = | 1123.74 | (268) |
| Primary energy kWh/year | | | | | 8641.04 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 99.90 | (273) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A 5 04 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 72.67 | (1a) | x | 2.50 | (2a) | = | 181.68 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 72.67 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 181.68 | (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) = | 0.11 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.31 | (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) = | 0.24 | (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 | 0.31 | 0.30 | 0.29 | 0.26 | 0.26 | 0.23 | 0.23 | 0.22 | 0.24 | 0.26 | 0.27 | 0.28 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.55 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.52 | 0.53 | 0.53 | 0.54 | 0.54 | (24d) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.55 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.52 | 0.53 | 0.53 | 0.54 | 0.54 | (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 | | | 25.07 | x | 1.24 | = | 30.98 | | | (27) |
| External wall | | | 30.28 | x | 0.18 | = | 5.45 | | | (29a) |
| Party wall | | | 38.70 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 72.67 | x | 0.12 | = | 8.72 | | | (30) |
| Total area of external elements ∑A, m² | | | 128.02 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 45.15 | (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 | | 17.76 | (36) |
| Total fabric heat loss | (33) + (36) = | 62.91 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 32.79 | 32.68 | 32.57 | 32.07 | 31.98 | 31.54 | 31.54 | 31.46 | 31.71 | 31.98 | 32.17 | 32.37 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 95.70 | 95.59 | 95.48 | 94.98 | 94.88 | 94.44 | 94.44 | 94.36 | 94.61 | 94.88 | 95.07 | 95.27 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 94.98 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.32 | 1.32 | 1.31 | 1.31 | 1.31 | 1.30 | 1.30 | 1.30 | 1.30 | 1.31 | 1.31 | 1.31 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.31 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.31 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.04 | (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) | 97.95 | 94.39 | 90.82 | 87.26 | 83.70 | 80.14 | 80.14 | 83.70 | 87.26 | 90.82 | 94.39 | 97.95 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1068.51 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 145.25 | 127.04 | 131.09 | 114.29 | 109.66 | 94.63 | 87.69 | 100.63 | 101.83 | 118.67 | 129.54 | 140.67 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1400.99 | (45) |
| Distribution loss 0.15 x (45)m | 21.79 | 19.06 | 19.66 | 17.14 | 16.45 | 14.19 | 13.15 | 15.09 | 15.27 | 17.80 | 19.43 | 21.10 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.20 | 151.38 | 158.04 | 140.37 | 136.61 | 120.71 | 114.64 | 127.57 | 127.91 | 145.62 | 155.62 | 167.62 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.20 | 151.38 | 158.04 | 140.37 | 136.61 | 120.71 | 114.64 | 127.57 | 127.91 | 145.62 | 155.62 | 167.62 | |

∑(64)1...12 = 1718.28 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 69.85 | 61.71 | 65.15 | 58.86 | 58.02 | 52.33 | 50.72 | 55.02 | 54.72 | 61.02 | 63.93 | 68.33 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | | | | | | | | | | | | | |
| | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| | 18.14 | 16.11 | 13.10 | 9.92 | 7.41 | 6.26 | 6.76 | 8.79 | 11.80 | 14.98 | 17.49 | 18.64 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| | 203.45 | 205.56 | 200.24 | 188.91 | 174.62 | 161.18 | 152.20 | 150.09 | 155.41 | 166.74 | 181.03 | 194.47 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | (69) |
| Pump and fan gains (Table 5a) | | | | | | | | | | | | | |
| | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | | | | | | | | | | | | | |
| | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | (71) |
| Water heating gains (Table 5) | | | | | | | | | | | | | |
| | 93.89 | 91.83 | 87.56 | 81.76 | 77.99 | 72.68 | 68.17 | 73.95 | 76.00 | 82.01 | 88.80 | 91.84 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | | | | | | | | | | | | | |
| | 373.11 | 371.14 | 358.54 | 338.22 | 317.65 | 297.75 | 284.77 | 290.47 | 300.85 | 321.37 | 344.96 | 362.59 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthEast | 0.77 | x | 13.39 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 172.08 | (77) |
| NorthWest | 0.77 | x | 6.14 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 24.20 | (81) |
| NorthEast | 0.77 | x | 3.44 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 13.56 | (75) |
| SouthWest | 0.77 | x | 2.10 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 26.99 | (79) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 236.82 | 415.93 | 602.40 | 802.23 | 949.52 | 965.07 | 921.10 | 807.79 | 671.06 | 468.67 | 285.93 | 201.19 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 609.93 | 787.06 | 960.93 | 1140.45 | 1267.17 | 1262.82 | 1205.87 | 1098.25 | 971.91 | 790.03 | 630.89 | 563.78 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 0.99 | 0.98 | 0.93 | 0.82 | 0.65 | 0.47 | 0.34 | 0.39 | 0.63 | 0.90 | 0.98 | 0.99 | (86) |
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 19.75 | 20.03 | 20.39 | 20.73 | 20.92 | 20.99 | 21.00 | 21.00 | 20.95 | 20.65 | 20.12 | 19.69 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(˚C) | 19.83 | 19.83 | 19.83 | 19.84 | 19.84 | 19.84 | 19.84 | 19.84 | 19.84 | 19.84 | 19.83 | 19.83 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 0.99 | 0.97 | 0.91 | 0.78 | 0.58 | 0.39 | 0.25 | 0.29 | 0.54 | 0.86 | 0.97 | 0.99 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 18.21 | 18.61 | 19.10 | 19.56 | 19.77 | 19.83 | 19.84 | 19.84 | 19.81 | 19.47 | 18.74 | 18.12 | (90) |

| | | | |
|---|---|---|---|
| Living area fraction | Living area ÷ (4) = | 0.39 | (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 | 18.82 | 19.17 | 19.61 | 20.02 | 20.23 | 20.29 | 20.30 | 20.30 | 20.26 | 19.94 | 19.28 | 18.74 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 18.82 | 19.17 | 19.61 | 20.02 | 20.23 | 20.29 | 20.30 | 20.30 | 20.26 | 19.94 | 19.28 | 18.74 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.96 | 0.91 | 0.79 | 0.61 | 0.42 | 0.29 | 0.33 | 0.57 | 0.86 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 601.52 | 757.92 | 872.98 | 897.35 | 767.58 | 530.82 | 348.18 | 365.89 | 558.49 | 681.99 | 612.00 | 558.05 | (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] | 1389.12 | 1363.88 | 1251.59 | 1056.36 | 809.08 | 537.12 | 349.05 | 367.55 | 582.55 | 885.91 | 1158.11 | 1385.37 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 585.97 | 407.20 | 281.69 | 114.49 | 30.88 | 0.00 | 0.00 | 0.00 | 0.00 | 151.71 | 393.20 | 615.52 | |

| | | | |
|---|---|---|---|
| | ∑(98)1...5, 10...12 = | 2580.66 | (98) |
| Space heating requirement kWh/m²/year | (98) ÷ (4) | 35.51 | (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 | 2580.66 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 2709.69 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1718.28 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1804.19 | (310a) |

| | | | |
|---|---|---|---|
| Electricity used for heat distribution | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 45.14 | (313) |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| Total electricity for the above, kWh/year | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | 320.31 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4834.20 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 2709.69 | x | 4.24 | x 0.01 = | 114.89 | (340a) |
| Water heating from boilers | 1804.19 | x | 4.24 | x 0.01 = | 76.50 | (342a) |
| Electricity for lighting | 320.31 | x | 13.19 | x 0.01 = | 42.25 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 353.64 | (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) = | 5043.45 | x | 0.216 | = | 1089.38 | (367) |
| Electrical energy for community heat distribution | | 45.14 | x | 0.519 | = | 23.43 | (372) |
| Total CO2 associated with community systems | | | | | | 1112.81 | (373) |
| Total CO2 associated with space and water heating | | | | | | 1112.81 | (376) |
| Electricity for lighting | | 320.31 | x | 0.519 | = | 166.24 | (379) |
| Total $CO_2$, kg/year | | | | | (376)..(382) = | 1279.05 | (383) |
| Dwelling $CO_2$ emission rate | | | | | (383) ÷ (4) = | 17.60 | (384) |
| EI value | | | | | | 85.43 | |
| 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) = | 5043.45 | x | 1.22 | = | 6153.00 | (367) |
| Electrical energy for community heat distribution | | 45.14 | x | 3.07 | = | 138.58 | (372) |
| Total primary energy associated with community systems | | | | | | 6291.58 | (373) |
| Total primary energy associated with space and water heating | | | | | | 6291.58 | (376) |
| Electricity for lighting | | 320.31 | x | 3.07 | = | 983.36 | (379) |
| Primary energy kWh/year | | | | | | 7274.94 | (383) |

| | | |
|---|---|---|
| Dwelling primary energy rate kWh/m2/year | 100.11 | (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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
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## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 72.67 | (1a) | x | 2.50 | (2a) | = | 181.68 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 72.67 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 181.68 | (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 | | 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 | 0.41 | 0.40 | 0.39 | 0.35 | 0.35 | 0.31 | 0.31 | 0.30 | 0.32 | 0.35 | 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) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d) | 0.58 | 0.58 | 0.58 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.55 | 0.56 | 0.57 | 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 | 0.57 | 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 | | | 18.17 | x | 1.33 | = | 24.09 | | | (27) |
| External wall | | | 37.18 | x | 0.18 | = | 6.69 | | | (29a) |
| Party wall | | | 38.70 | x | 0.00 | = | 0.00 | | | (32) |
| Roof | | | 72.67 | x | 0.13 | = | 9.45 | | | (30) |
| Total area of external elements ∑A, m² | | | 128.02 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 40.23 | (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 | | 18.48 | (36) |
| Total fabric heat loss | (33) + (36) = | 58.71 | (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) | 35.02 | 34.82 | 34.63 | 33.73 | 33.56 | 32.78 | 32.78 | 32.63 | 33.08 | 33.56 | 33.90 | 34.26 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 93.73 | 93.54 | 93.34 | 92.44 | 92.27 | 91.49 | 91.49 | 91.34 | 91.79 | 92.27 | 92.61 | 92.97 | |

Average = ∑(39)1...12/12 = 92.44 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.29 | 1.29 | 1.28 | 1.27 | 1.27 | 1.26 | 1.26 | 1.26 | 1.26 | 1.27 | 1.27 | 1.28 | |

Average = ∑(40)1...12/12 = 1.27 (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 | 2.31 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.04 | (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) | 97.95 | 94.39 | 90.82 | 87.26 | 83.70 | 80.14 | 80.14 | 83.70 | 87.26 | 90.82 | 94.39 | 97.95 | |

∑(44)1...12 = 1068.51 (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) | 145.25 | 127.04 | 131.09 | 114.29 | 109.66 | 94.63 | 87.69 | 100.63 | 101.83 | 118.67 | 129.54 | 140.67 | |

∑(45)1...12 = 1400.99 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 21.79 | 19.06 | 19.66 | 17.14 | 16.45 | 14.19 | 13.15 | 15.09 | 15.27 | 17.80 | 19.43 | 21.10 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.51 | 151.66 | 158.35 | 140.67 | 136.92 | 121.01 | 114.95 | 127.89 | 128.21 | 145.93 | 155.92 | 167.93 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 172.51 | 151.66 | 158.35 | 140.67 | 136.92 | 121.01 | 114.95 | 127.89 | 128.21 | 145.93 | 155.92 | 167.93 | |
| | | | | | | | | | | ∑(64)1...12 = | 1721.95 | (64) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.10 | 61.94 | 65.40 | 59.11 | 58.27 | 52.57 | 50.96 | 55.27 | 54.96 | 61.27 | 64.18 | 68.58 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | 115.46 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.14 | 16.11 | 13.10 | 9.92 | 7.41 | 6.26 | 6.76 | 8.79 | 11.80 | 14.98 | 17.49 | 18.64 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 203.45 | 205.56 | 200.24 | 188.91 | 174.62 | 161.18 | 152.20 | 150.09 | 155.41 | 166.74 | 181.03 | 194.47 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | 34.55 | (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) | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | -92.37 | (71) |
| Water heating gains (Table 5) | 94.23 | 92.17 | 87.90 | 82.09 | 78.32 | 73.01 | 68.50 | 74.28 | 76.34 | 82.35 | 89.13 | 92.18 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 376.45 | 374.47 | 361.87 | 341.56 | 320.99 | 301.09 | 288.10 | 293.80 | 304.18 | 324.70 | 348.29 | 365.93 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthEast | 0.77 | x | 9.71 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 109.19 | (77) |
| NorthWest | 0.77 | x | 4.44 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 15.31 | (81) |
| NorthEast | 0.77 | x | 2.50 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 8.62 | (75) |
| SouthWest | 0.77 | x | 1.52 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 17.09 | (79) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 150.21 | 263.81 | 382.07 | 508.79 | 602.19 | 612.04 | 584.16 | 512.31 | 425.61 | 297.26 | 181.36 | 127.61 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 526.66 | 638.28 | 743.94 | 850.35 | 923.18 | 913.13 | 872.27 | 806.11 | 729.80 | 621.96 | 529.65 | 493.54 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1.00 | 0.99 | 0.97 | 0.91 | 0.79 | 0.61 | 0.45 | 0.51 | 0.76 | 0.95 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.69 | 19.90 | 20.20 | 20.57 | 20.84 | 20.96 | 20.99 | 20.99 | 20.90 | 20.53 | 20.04 | 19.65 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.85 | 19.85 | 19.85 | 19.86 | 19.86 | 19.87 | 19.87 | 19.87 | 19.87 | 19.86 | 19.86 | 19.86 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.99 | 0.96 | 0.89 | 0.73 | 0.52 | 0.34 | 0.39 | 0.67 | 0.93 | 0.99 | 1.00 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.12 | 18.43 | 18.87 | 19.38 | 19.72 | 19.85 | 19.87 | 19.87 | 19.80 | 19.35 | 18.64 | 18.07 | (90) |

Living area fraction — Living area ÷ (4) = 0.39 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.74 | 19.01 | 19.39 | 19.85 | 20.16 | 20.29 | 20.31 | 20.31 | 20.23 | 19.81 | 19.19 | 18.69 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.74 | 19.01 | 19.39 | 19.85 | 20.16 | 20.29 | 20.31 | 20.31 | 20.23 | 19.81 | 19.19 | 18.69 | (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 | 0.89 | 0.75 | 0.55 | 0.39 | 0.44 | 0.70 | 0.92 | 0.98 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | |
| 522.41 | 626.38 | 710.70 | 753.51 | 690.26 | 503.66 | 337.11 | 352.72 | 513.11 | 574.81 | 520.82 | 490.50 | (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] | | | | | | | | | | | | |
| 1353.52 | 1319.53 | 1203.67 | 1012.19 | 780.59 | 520.49 | 339.63 | 357.16 | 562.86 | 850.20 | 1119.70 | 1347.52 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | | | | | | | | | | | | |
| 618.35 | 465.79 | 366.77 | 186.25 | 67.20 | 0.00 | 0.00 | 0.00 | 0.00 | 204.88 | 431.19 | 637.62 | |

∑(98)1...5, 10...12 = 2978.05 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 40.98 (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 | | | | | | | | | | | | |
| 661.33 | 498.18 | 392.26 | 199.20 | 71.87 | 0.00 | 0.00 | 0.00 | 0.00 | 219.13 | 461.17 | 681.94 | |

∑(211)1...5, 10...12 = 3185.08 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.93 | 87.61 | 86.98 | 85.56 | 83.03 | 79.80 | 79.80 | 79.80 | 79.80 | 85.72 | 87.39 | 88.04 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 196.20 | 173.10 | 182.05 | 164.40 | 164.91 | 151.64 | 144.05 | 160.26 | 160.66 | 170.24 | 178.42 | 190.74 |

∑(219a)1...12 = 2036.67 (219)

**Annual totals**

| | | | |
|---|---|---|---|
| Space heating fuel - main system 1 | | 3185.08 | |
| Water heating fuel | | 2036.67 | |
| 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) | | 320.31 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 5617.07 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3185.08 | x | 3.48 | x 0.01 = | 110.84 | (240) |
| Water heating | 2036.67 | x | 3.48 | x 0.01 = | 70.88 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 320.31 | x | 13.19 | x 0.01 = | 42.25 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 353.86 | (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 | 82.38 | |
| 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 | 3185.08 | x | 0.216 | = | 687.98 | (261) |
| Water heating | 2036.67 | x | 0.216 | = | 439.92 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 1127.90 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 320.31 | x | 0.519 | = | 166.24 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1333.07 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 18.34 | (273) |
| EI value | | | | | 84.82 | |
| 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 | 3185.08 | x | 1.22 | = | 3885.80 | (261) |
| Water heating | 2036.67 | x | 1.22 | = | 2484.74 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 6370.55 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 320.31 | x | 3.07 | = | 983.36 | (268) |
| Primary energy kWh/year | | | | | 7584.16 | (272) |

| | | |
|---|---|---|
| Dwelling primary energy rate kWh/m2/year | 104.36 | (273) |

# DER Worksheet
# Design - Draft

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A G 01 Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area ($m^2$) | | | Average storey height (m) | | | Volume ($m^3$) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.40 | (1a) | x | 3.00 | (2a) | = | 223.20 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.40 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 223.20 | (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 | | 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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.33 | (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) = | 0.26 | (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 | 0.33 | 0.32 | 0.32 | 0.29 | 0.28 | 0.25 | 0.25 | 0.24 | 0.26 | 0.28 | 0.29 | 0.30 | (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 | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (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 | | | 30.15 | x | 1.24 | = | 37.26 | | | (27) |
| Exposed floor | | | 74.40 | x | 0.12 | = | 8.93 | | | (28b |
| External wall | | | 59.58 | x | 0.18 | = | 10.72 | | | (29a) |
| Party wall | | | 62.62 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 164.13 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 56.91 | (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 | | 23.35 | (36) |
| Total fabric heat loss | (33) + (36) = | 80.26 | (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) | 40.85 | 40.69 | 40.54 | 39.82 | 39.69 | 39.06 | 39.06 | 38.94 | 39.30 | 39.69 | 39.96 | 40.24 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 121.11 | 120.96 | 120.80 | 120.08 | 119.95 | 119.32 | 119.32 | 119.21 | 119.56 | 119.95 | 120.22 | 120.51 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 120.08 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.63 | 1.63 | 1.62 | 1.61 | 1.61 | 1.60 | 1.60 | 1.60 | 1.61 | 1.61 | 1.62 | 1.62 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.61 | (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 | 2.35 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.97 | (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) | 98.96 | 95.36 | 91.77 | 88.17 | 84.57 | 80.97 | 80.97 | 84.57 | 88.17 | 91.77 | 95.36 | 98.96 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1079.59 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.76 | 128.36 | 132.45 | 115.47 | 110.80 | 95.61 | 88.60 | 101.67 | 102.88 | 119.90 | 130.88 | 142.13 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1415.52 | (45) |
| Distribution loss 0.15 x (45)m | 22.01 | 19.25 | 19.87 | 17.32 | 16.62 | 14.34 | 13.29 | 15.25 | 15.43 | 17.99 | 19.63 | 21.32 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 173.71 | 152.70 | 159.40 | 141.55 | 137.75 | 121.69 | 115.55 | 128.62 | 128.96 | 146.85 | 156.96 | 169.08 | |

∑(64)1...12 = 1732.81 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.36 | 62.15 | 65.60 | 59.26 | 58.40 | 52.65 | 51.02 | 55.36 | 55.07 | 61.43 | 64.38 | 68.82 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.48 | 16.42 | 13.35 | 10.11 | 7.56 | 6.38 | 6.89 | 8.96 | 12.03 | 15.27 | 17.82 | 19.00 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 207.34 | 209.49 | 204.07 | 192.53 | 177.96 | 164.26 | 155.12 | 152.96 | 158.39 | 169.93 | 184.50 | 198.19 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | (69) |
| Pump and fan gains (Table 5a) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (70) |
| Losses e.g. evaporation (Table 5) | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | (71) |
| Water heating gains (Table 5) | 94.56 | 92.49 | 88.17 | 82.30 | 78.49 | 73.13 | 68.57 | 74.41 | 76.49 | 82.56 | 89.42 | 92.49 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 378.61 | 376.62 | 363.81 | 343.16 | 322.23 | 302.00 | 288.80 | 294.56 | 305.12 | 325.98 | 349.96 | 367.91 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.68 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 214.36 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |
| NorthWest | 0.77 | x | 10.00 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 39.41 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 298.36 | 521.30 | 748.04 | 985.13 | 1156.62 | 1171.66 | 1119.87 | 988.35 | 829.58 | 585.52 | 359.75 | 253.79 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 676.97 | 897.92 | 1111.85 | 1328.29 | 1478.85 | 1473.65 | 1408.67 | 1282.91 | 1134.70 | 911.50 | 709.71 | 621.70 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.97 | 0.93 | 0.83 | 0.67 | 0.50 | 0.37 | 0.42 | 0.65 | 0.90 | 0.98 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.43 | 19.75 | 20.16 | 20.59 | 20.86 | 20.97 | 20.99 | 20.99 | 20.90 | 20.50 | 19.86 | 19.36 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.59 | 19.59 | 19.60 | 19.60 | 19.60 | 19.61 | 19.61 | 19.61 | 19.61 | 19.60 | 19.60 | 19.60 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.96 | 0.91 | 0.78 | 0.59 | 0.40 | 0.25 | 0.30 | 0.55 | 0.86 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 17.58 | 18.04 | 18.62 | 19.18 | 19.49 | 19.59 | 19.61 | 19.61 | 19.55 | 19.09 | 18.21 | 17.49 | (90) |

Living area fraction — Living area ÷ (4) = 0.36 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.24 | 18.65 | 19.17 | 19.68 | 19.97 | 20.08 | 20.10 | 20.10 | 20.03 | 19.59 | 18.80 | 18.15 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.24 | 18.65 | 19.17 | 19.68 | 19.97 | 20.08 | 20.10 | 20.10 | 20.03 | 19.59 | 18.80 | 18.15 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.98 | 0.95 | 0.90 | 0.78 | 0.62 | 0.43 | 0.29 | 0.34 | 0.58 | 0.86 | 0.96 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 664.72 | 857.31 | 999.08 | 1041.80 | 911.13 | 638.18 | 415.05 | 436.25 | 661.26 | 780.04 | 683.79 | 613.20 | (95) |
| Monthly average external temperature from Table U1 | 4.30 | 4.90 | 6.50 | 8.90 | 11.70 | 14.60 | 16.60 | 16.40 | 14.10 | 10.60 | 7.10 | 4.20 | (96) |
| Heat loss rate for mean internal temperature, Lm, W [(39)m x [(93)m - (96)m] | 1687.94 | 1663.10 | 1530.42 | 1294.76 | 992.48 | 653.94 | 417.66 | 440.81 | 708.93 | 1078.80 | 1406.65 | 1681.57 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 761.27 | 541.49 | 395.31 | 182.13 | 60.52 | 0.00 | 0.00 | 0.00 | 0.00 | 222.28 | 520.46 | 794.87 | |

∑(98)1...5, 10...12 = 3478.34 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 46.75 (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 | 3478.34 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 3652.25 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1732.81 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1819.45 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 54.72 | (313) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | | |
| Total electricity for the above, kWh/year | | | | | 0.00 | (331) |
| Electricity for lighting (Appendix L) | | | | | 326.44 | (332) |
| Total delivered energy for all uses | (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | | | | 5798.15 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 3652.25 | x | 4.24 | x 0.01 = | 154.86 | (340a) |
| Water heating from boilers | 1819.45 | x | 4.24 | x 0.01 = | 77.14 | (342a) |
| Electricity for lighting | 326.44 | x | 13.19 | x 0.01 = | 43.06 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | (340a)...(342e) + (345)...(354) = | | 395.06 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.39 | (357) |
| SAP value | 80.61 | |
| SAP rating (section 13) | 81 | (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) = | 6113.63 | x | 0.216 | = | 1320.55 | (367) |
| Electrical energy for community heat distribution | 54.72 | x | 0.519 | = | 28.40 | (372) |
| Total CO2 associated with community systems | | | | | 1348.94 | (373) |
| Total CO2 associated with space and water heating | | | | | 1348.94 | (376) |
| Electricity for lighting | 326.44 | x | 0.519 | = | 169.42 | (379) |
| Total $CO_2$, kg/year | | | (376)..(382) = | | 1518.37 | (383) |
| Dwelling $CO_2$ emission rate | | | (383) ÷ (4) = | | 20.41 | (384) |
| EI value | | | | | 82.96 | |
| EI rating (section 14) | | | | | 83 | (385) |
| EI band | | | | | B | |

## 13b. Primary energy - community heating scheme

| | Energy kWh/year | | Primary factor | | Primary energy (kWh/year) | |
|---|---|---|---|---|---|---|
| Primary energy from other sources (space heating) | | | | | | |
| Efficiency of boilers | 89.50 | | | | | (367a) |
| Primary energy from boilers [(307a)+(310a)] x 100 ÷ (367a) = | 6113.63 | x | 1.22 | = | 7458.63 | (367) |
| Electrical energy for community heat distribution | 54.72 | x | 3.07 | = | 167.98 | (372) |
| Total primary energy associated with community systems | | | | | 7626.62 | (373) |
| Total primary energy associated with space and water heating | | | | | 7626.62 | (376) |
| Electricity for lighting | 326.44 | x | 3.07 | = | 1002.18 | (379) |
| Primary energy kWh/year | | | | | 8628.80 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 115.98 | (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.

| | | | |
|---|---|---|---|
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## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 74.40 | (1a) | x | 3.00 | (2a) | = | 223.20 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 74.40 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 223.20 | (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 | 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 | | 3 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.78 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.30 | (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 | 0.38 | 0.37 | 0.36 | 0.33 | 0.32 | 0.28 | 0.28 | 0.28 | 0.30 | 0.32 | 0.34 | 0.35 | (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 | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (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 | | | 18.60 | x | 1.33 | = | 24.66 | | | (27) |
| Exposed floor | | | 74.40 | x | 0.13 | = | 9.67 | | | (28b |
| External wall | | | 71.14 | x | 0.18 | = | 12.81 | | | (29a) |
| Party wall | | | 62.62 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 164.14 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 47.14 | (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 | | 16.43 | (36) |
| Total fabric heat loss | (33) + (36) = | 63.57 | (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) | 42.14 | 41.94 | 41.73 | 40.78 | 40.61 | 39.78 | 39.78 | 39.62 | 40.10 | 40.61 | 40.96 | 41.34 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 105.71 | 105.50 | 105.30 | 104.35 | 104.17 | 103.34 | 103.34 | 103.19 | 103.66 | 104.17 | 104.53 | 104.91 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 104.35 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.42 | 1.42 | 1.42 | 1.40 | 1.40 | 1.39 | 1.39 | 1.39 | 1.39 | 1.40 | 1.40 | 1.41 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.40 | (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 | 2.35 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 89.97 | (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) | 98.96 | 95.36 | 91.77 | 88.17 | 84.57 | 80.97 | 80.97 | 84.57 | 88.17 | 91.77 | 95.36 | 98.96 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1079.59 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 146.76 | 128.36 | 132.45 | 115.47 | 110.80 | 95.61 | 88.60 | 101.67 | 102.88 | 119.90 | 130.88 | 142.13 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1415.52 | (45) |
| Distribution loss 0.15 x (45)m | 22.01 | 19.25 | 19.87 | 17.32 | 16.62 | 14.34 | 13.29 | 15.25 | 15.43 | 17.99 | 19.63 | 21.32 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 174.02 | 152.98 | 159.71 | 141.86 | 138.06 | 121.99 | 115.86 | 128.93 | 129.26 | 147.16 | 157.26 | 169.39 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 174.02 | 152.98 | 159.71 | 141.86 | 138.06 | 121.99 | 115.86 | 128.93 | 129.26 | 147.16 | 157.26 | 169.39 | |

∑(64)1...12 = 1736.48 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 70.61 | 62.38 | 65.85 | 59.50 | 58.65 | 52.90 | 51.27 | 55.61 | 55.31 | 61.68 | 64.62 | 69.07 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | 117.40 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.48 | 16.42 | 13.35 | 10.11 | 7.56 | 6.38 | 6.89 | 8.96 | 12.03 | 15.27 | 17.82 | 19.00 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 207.34 | 209.49 | 204.07 | 192.53 | 177.96 | 164.26 | 155.12 | 152.96 | 158.39 | 169.93 | 184.50 | 198.19 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | 34.74 | (69) |
| Pump and fan gains (Table 5a) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |
| Losses e.g. evaporation (Table 5) | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | -93.92 | (71) |
| Water heating gains (Table 5) | 94.90 | 92.82 | 88.51 | 82.64 | 78.83 | 73.47 | 68.91 | 74.75 | 76.82 | 82.90 | 89.75 | 92.83 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 381.95 | 379.95 | 367.15 | 346.50 | 325.56 | 305.33 | 292.14 | 297.89 | 308.46 | 329.31 | 353.29 | 371.24 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 10.29 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 115.71 | (79) |
| SouthEast | 0.77 | x | 2.14 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 24.06 | (77) |
| NorthWest | 0.77 | x | 6.17 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 21.28 | (81) |

Solar gains in watts ∑(74)m...(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 161.05 | 281.39 | 403.78 | 531.77 | 624.34 | 632.46 | 604.50 | 533.50 | 447.80 | 316.06 | 194.18 | 136.99 | (83) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 542.99 | 661.34 | 770.93 | 878.26 | 949.90 | 937.79 | 896.64 | 831.40 | 756.25 | 645.37 | 547.48 | 508.23 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 1.00 | 0.99 | 0.97 | 0.93 | 0.82 | 0.65 | 0.49 | 0.55 | 0.79 | 0.95 | 0.99 | 1.00 | (86) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Mean internal temp of living area T1 (steps 3 to 7 in Table 9c) | 19.53 | 19.74 | 20.06 | 20.46 | 20.77 | 20.94 | 20.99 | 20.98 | 20.86 | 20.44 | 19.90 | 19.49 | (87) |
| Temperature during heating periods in the rest of dwelling from Table 9, Th2(°C) | 19.75 | 19.75 | 19.75 | 19.76 | 19.76 | 19.77 | 19.77 | 19.77 | 19.77 | 19.76 | 19.76 | 19.76 | (88) |
| Utilisation factor for gains for rest of dwelling n2,m | 0.99 | 0.99 | 0.96 | 0.90 | 0.76 | 0.55 | 0.36 | 0.41 | 0.70 | 0.93 | 0.99 | 1.00 | (89) |
| Mean internal temperature in the rest of dwelling T2 (follow steps 3 to 7 in Table 9c) | 17.82 | 18.14 | 18.60 | 19.15 | 19.55 | 19.73 | 19.77 | 19.77 | 19.66 | 19.14 | 18.38 | 17.77 | (90) |

Living area fraction — Living area ÷ (4) = 0.36 (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 | 18.43 | 18.71 | 19.12 | 19.62 | 19.99 | 20.16 | 20.20 | 20.20 | 20.09 | 19.60 | 18.92 | 18.38 | (92) |
| Apply adjustment to the mean internal temperature from Table 4e where appropriate | 18.43 | 18.71 | 19.12 | 19.62 | 19.99 | 20.16 | 20.20 | 20.20 | 20.09 | 19.60 | 18.92 | 18.38 | (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 | 0.89 | 0.77 | 0.58 | 0.41 | 0.46 | 0.72 | 0.93 | 0.98 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 538.32 | 648.70 | 737.40 | 785.92 | 732.14 | 546.05 | 367.21 | 383.66 | 547.87 | 598.65 | 538.10 | 504.86 | (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] | 1493.40 | 1456.74 | 1328.94 | 1118.28 | 863.09 | 574.85 | 372.07 | 391.73 | 620.68 | 937.48 | 1235.39 | 1487.48 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 710.58 | 543.00 | 440.11 | 239.30 | 97.43 | 0.00 | 0.00 | 0.00 | 0.00 | 252.09 | 502.05 | 731.07 | |

∑(98)1...5, 10...12 = 3515.63 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 47.25 (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 | 759.98 | 580.75 | 470.70 | 255.94 | 104.20 | 0.00 | 0.00 | 0.00 | 0.00 | 269.62 | 536.95 | 781.89 |

∑(211)1...5, 10...12 = 3760.03 (211)

**Water heating**

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Efficiency of water heater | 88.17 | 87.91 | 87.38 | 86.20 | 83.90 | 79.80 | 79.80 | 79.80 | 79.80 | 86.24 | 87.70 | 88.27 | (217) |
| Water heating fuel, kWh/month | 197.36 | 174.02 | 182.78 | 164.57 | 164.55 | 152.87 | 145.19 | 161.57 | 161.98 | 170.64 | 179.33 | 191.89 | |

∑(219a)1...12 = 2046.74 (219)

**Annual totals**

| | | | |
|---|---|---|---|
| Space heating fuel - main system 1 | | 3760.03 | |
| Water heating fuel | | 2046.74 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | |
| central heating pump or water pump within warm air heating unit | 30.00 | | (230c) |
| boiler flue fan | 45.00 | | (230e) |
| Total electricity for the above, kWh/year | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | 326.44 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 6208.22 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3760.03 | x | 3.48 | x 0.01 = | 130.85 | (240) |
| Water heating | 2046.74 | x | 3.48 | x 0.01 = | 71.23 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 326.44 | x | 13.19 | x 0.01 = | 43.06 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | (240)...(242) + (245)...(254) = | | 375.03 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.32 | (257) |
| SAP value | 81.60 | |
| 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 | 3760.03 | x | 0.216 | = | 812.17 | (261) |
| Water heating | 2046.74 | x | 0.216 | = | 442.10 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 1254.26 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 326.44 | x | 0.519 | = | 169.42 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1462.61 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 19.66 | (273) |
| EI value | | | | | 83.59 | |
| EI rating (section 14) | | | | | 84 | (274) |
| EI band | | | | | B | |

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

| | Energy kWh/year | | Primary factor | | Primary Energy kWh/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 3760.03 | x | 1.22 | = | 4587.24 | (261) |
| Water heating | 2046.74 | x | 1.22 | = | 2497.03 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 7084.26 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 326.44 | x | 3.07 | = | 1002.18 | (268) |
| Primary energy kWh/year | | | | | 8316.70 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 111.78 | (273) |

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
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## 1. Overall dwelling dimensions

| | | Area ($m^2$) | | | Average storey height (m) | | | Volume ($m^3$) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 76.52 | (1a) | x | 3.00 | (2a) | = | 229.56 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 76.52 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 229.56 | (5) |

## 2. Ventilation rate

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

| | | | | Air changes per hour | |
|---|---|---|---|---|---|
| Infiltration due to chimneys, flues, fans, PSVs | (6a) + (6b) + (7a) + (7b) + (7c) = | 30 | ÷ (5) = | 0.13 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.33 | (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) = | 0.26 | (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 | 0.33 | 0.32 | 0.31 | 0.28 | 0.28 | 0.24 | 0.24 | 0.24 | 0.26 | 0.28 | 0.29 | 0.30 | (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 | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (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 | | | 19.92 | x | 1.24 | = | 24.62 | | | (27) |
| Exposed floor | | | 76.52 | x | 0.12 | = | 9.18 | | | (28b |
| External wall | | | 23.53 | x | 0.18 | = | 4.24 | | | (29a) |
| Party wall | | | 85.38 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 119.97 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 38.03 | (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 | | 16.12 | (36) |
| Total fabric heat loss | (33) + (36) = | 54.15 | (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) | 41.92 | 41.76 | 41.61 | 40.89 | 40.75 | 40.12 | 40.12 | 40.01 | 40.37 | 40.75 | 41.03 | 41.31 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 96.07 | 95.92 | 95.76 | 95.04 | 94.90 | 94.28 | 94.28 | 94.16 | 94.52 | 94.90 | 95.18 | 95.46 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 95.04 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.26 | 1.25 | 1.25 | 1.24 | 1.24 | 1.23 | 1.23 | 1.23 | 1.24 | 1.24 | 1.24 | 1.25 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.24 | (40) |
| Number of days in month (Table 1a) | 31.00 | 28.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | 31.00 | 30.00 | 31.00 | 30.00 | 31.00 | (40) |

## 4. Water heating energy requirement

| | | |
|---|---|---|
| Assumed occupancy, N | 2.39 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 91.05 | (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) | 100.15 | 96.51 | 92.87 | 89.23 | 85.58 | 81.94 | 81.94 | 85.58 | 89.23 | 92.87 | 96.51 | 100.15 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1092.55 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 148.52 | 129.90 | 134.04 | 116.86 | 112.13 | 96.76 | 89.66 | 102.89 | 104.12 | 121.34 | 132.45 | 143.83 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1432.51 | (45) |
| Distribution loss 0.15 x (45)m | 22.28 | 19.48 | 20.11 | 17.53 | 16.82 | 14.51 | 13.45 | 15.43 | 15.62 | 18.20 | 19.87 | 21.58 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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 | 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 | (62) |
| Solar DHW input calculated using Appendix G or Appendix H | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | (63) |
| Output from water heater for each month (kWh/month) (62)m + (63)m | 175.47 | 154.24 | 160.99 | 142.94 | 139.08 | 122.84 | 116.61 | 129.84 | 130.20 | 148.29 | 158.53 | 170.78 | |
| | | | | | | | | | | | ∑(64)1...12 = | 1749.80 | (64) |
| Heat gains from water heating (kWh/month) 0.25 × [0.85 × (45)m + (61)m] + 0.8 × [(46)m + (57)m + (59)m] | 70.94 | 62.66 | 66.13 | 59.72 | 58.84 | 53.04 | 51.37 | 55.77 | 55.48 | 61.90 | 64.90 | 69.38 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.90 | 16.79 | 13.65 | 10.34 | 7.73 | 6.52 | 7.05 | 9.16 | 12.30 | 15.61 | 18.22 | 19.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 212.01 | 214.21 | 208.67 | 196.87 | 181.97 | 167.97 | 158.61 | 156.41 | 161.96 | 173.76 | 188.66 | 202.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | (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) | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | (71) |
| Water heating gains (Table 5) | 95.35 | 93.25 | 88.88 | 82.94 | 79.09 | 73.66 | 69.05 | 74.96 | 77.06 | 83.20 | 90.14 | 93.26 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 385.17 | 383.15 | 370.11 | 349.05 | 327.69 | 307.05 | 293.61 | 299.43 | 310.21 | 331.48 | 355.93 | 374.25 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 16.45 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 211.40 | (79) |
| SouthEast | 0.77 | x | 3.47 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 44.59 | (77) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | 255.99 | 436.05 | 596.62 | 739.25 | 828.02 | 822.03 | 792.52 | 726.30 | 646.02 | 481.93 | 306.62 | 219.08 | (83) |
| Total gains - internal and solar (73)m + (83)m | 641.16 | 819.20 | 966.73 | 1088.30 | 1155.70 | 1129.08 | 1086.13 | 1025.73 | 956.23 | 813.41 | 662.55 | 593.32 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.94 | 0.85 | 0.70 | 0.52 | 0.38 | 0.42 | 0.64 | 0.89 | 0.98 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.83 | 20.10 | 20.42 | 20.73 | 20.91 | 20.98 | 21.00 | 20.99 | 20.95 | 20.69 | 20.19 | 19.78 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.88 | 19.88 | 19.88 | 19.89 | 19.89 | 19.89 | 19.89 | 19.90 | 19.89 | 19.89 | 19.89 | 19.88 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.97 | 0.92 | 0.81 | 0.63 | 0.44 | 0.29 | 0.32 | 0.55 | 0.86 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.36 | 18.74 | 19.18 | 19.59 | 19.81 | 19.88 | 19.89 | 19.89 | 19.86 | 19.56 | 18.87 | 18.28 | (90) |

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.87 | 19.21 | 19.61 | 19.99 | 20.19 | 20.27 | 20.28 | 20.28 | 20.24 | 19.95 | 19.33 | 18.80 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.87 | 19.21 | 19.61 | 19.99 | 20.19 | 20.27 | 20.28 | 20.28 | 20.24 | 19.95 | 19.33 | 18.80 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.96 | 0.91 | 0.81 | 0.65 | 0.47 | 0.32 | 0.35 | 0.58 | 0.86 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 632.11 | 788.29 | 882.71 | 883.49 | 755.26 | 525.98 | 345.54 | 363.22 | 557.79 | 699.15 | 641.78 | 587.17 | (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] | 1399.60 | 1372.92 | 1255.67 | 1053.70 | 805.99 | 534.08 | 346.57 | 364.94 | 580.38 | 887.57 | 1164.01 | 1393.58 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 571.02 | 392.87 | 277.48 | 122.55 | 37.74 | 0.00 | 0.00 | 0.00 | 0.00 | 140.18 | 376.01 | 599.96 | |

∑(98)1...5, 10...12 = 2517.81 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 32.90 (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 | 2517.81 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 2643.70 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1749.80 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1837.29 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 44.81 | (313) |

| | | |
|---|---|---|
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | |
| Total electricity for the above, kWh/year | 0.00 | (331) |
| Electricity for lighting (Appendix L) | 333.80 | (332) |
| Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 4814.80 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 2643.70 | x | 4.24 | x 0.01 = | 112.09 | (340a) |
| Water heating from boilers | 1837.29 | x | 4.24 | x 0.01 = | 77.90 | (342a) |
| Electricity for lighting | 333.80 | x | 13.19 | x 0.01 = | 44.03 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 354.02 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.22 | (357) |
| SAP value | 82.93 | |
| 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) = | 5006.70 | x | 0.216 | = | 1081.45 | (367) |
| Electrical energy for community heat distribution | 44.81 | x | 0.519 | = | 23.26 | (372) |
| Total CO2 associated with community systems | | | | | 1104.70 | (373) |
| Total CO2 associated with space and water heating | | | | | 1104.70 | (376) |
| Electricity for lighting | 333.80 | x | 0.519 | = | 173.24 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 1277.95 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 16.70 | (384) |
| EI value | | | | | 85.91 | |
| 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) = | 5006.70 | x | 1.22 | = | 6108.17 | (367) |
| Electrical energy for community heat distribution | 44.81 | x | 3.07 | = | 137.57 | (372) |
| Total primary energy associated with community systems | | | | | 6245.74 | (373) |
| Total primary energy associated with space and water heating | | | | | 6245.74 | (376) |
| Electricity for lighting | 333.80 | x | 3.07 | = | 1024.77 | (379) |
| Primary energy kWh/year | | | | | 7270.51 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 95.01 | (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 Alicja Kreglewska | Assessor number | 4134 |
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BASE CASE - GAS HEATING

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 76.52 | (1a) | x | 3.00 | (2a) | = | 229.56 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 76.52 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 229.56 | (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 | | 3 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.78 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.30 | (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 | 0.38 | 0.37 | 0.36 | 0.32 | 0.32 | 0.28 | 0.28 | 0.27 | 0.30 | 0.32 | 0.33 | 0.35 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (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 | | | 19.13 | x | 1.33 | = | 25.36 | | | (27) |
| Exposed floor | | | 76.52 | x | 0.13 | = | 9.95 | | | (28b |
| External wall | | | 24.33 | x | 0.18 | = | 4.38 | | | (29a) |
| Party wall | | | 85.38 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 119.98 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 39.69 | (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 | | 10.80 | (36) |
| Total fabric heat loss | (33) + (36) = | 50.49 | (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) | 43.24 | 43.03 | 42.82 | 41.87 | 41.69 | 40.85 | 40.85 | 40.70 | 41.17 | 41.69 | 42.05 | 42.43 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 93.72 | 93.52 | 93.31 | 92.35 | 92.18 | 91.34 | 91.34 | 91.19 | 91.60 | 92.18 | 92.54 | 92.92 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 92.35 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.22 | 1.22 | 1.22 | 1.21 | 1.20 | 1.19 | 1.19 | 1.19 | 1.20 | 1.20 | 1.21 | 1.21 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.21 | (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 | 2.39 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 91.05 | (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) | 100.15 | 96.51 | 92.87 | 89.23 | 85.58 | 81.94 | 81.94 | 85.58 | 89.23 | 92.87 | 96.51 | 100.15 | |
| ∑(44)1...12 = | | | | | | | | | | | | 1092.55 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 148.52 | 129.90 | 134.04 | 116.86 | 112.13 | 96.76 | 89.66 | 102.89 | 104.12 | 121.34 | 132.45 | 143.83 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1432.51 | (45) |
| Distribution loss 0.15 x (45)m | 22.28 | 19.48 | 20.11 | 17.53 | 16.82 | 14.51 | 13.45 | 15.43 | 15.62 | 18.20 | 19.87 | 21.58 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.78 | 154.52 | 161.30 | 143.24 | 139.39 | 123.14 | 116.92 | 130.15 | 130.50 | 148.60 | 158.83 | 171.09 | (62) |

Solar DHW input calculated using Appendix G or Appendix H

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

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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.78 | 154.52 | 161.30 | 143.24 | 139.39 | 123.14 | 116.92 | 130.15 | 130.50 | 148.60 | 158.83 | 171.09 |

∑(64)1...12 = 1753.47 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 71.19 | 62.89 | 66.38 | 59.96 | 59.09 | 53.28 | 51.62 | 56.02 | 55.72 | 62.15 | 65.14 | 69.63 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | 119.68 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 18.90 | 16.79 | 13.65 | 10.34 | 7.73 | 6.52 | 7.05 | 9.16 | 12.30 | 15.61 | 18.22 | 19.43 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 212.01 | 214.21 | 208.67 | 196.87 | 181.97 | 167.97 | 158.61 | 156.41 | 161.96 | 173.76 | 188.66 | 202.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | 34.97 | (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) | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | -95.74 | (71) |
| Water heating gains (Table 5) | 95.69 | 93.58 | 89.22 | 83.28 | 79.42 | 74.00 | 69.38 | 75.29 | 77.39 | 83.54 | 90.48 | 93.59 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 388.51 | 386.49 | 373.44 | 352.39 | 331.02 | 310.39 | 296.95 | 302.77 | 313.55 | 334.81 | 359.26 | 377.58 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthWest | 0.77 | x | 15.80 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 177.67 | (79) |
| SouthEast | 0.77 | x | 3.33 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 37.44 | (77) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | 215.11 | 366.41 | 501.34 | 621.19 | 695.78 | 690.75 | 665.96 | 610.31 | 542.85 | 404.96 | 257.65 | 184.09 | (83) |
| Total gains - internal and solar (73)m + (83)m | 603.62 | 752.90 | 874.78 | 973.57 | 1026.80 | 1001.14 | 962.90 | 913.08 | 856.40 | 739.78 | 616.91 | 561.67 | (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) | 0.99 | 0.98 | 0.95 | 0.88 | 0.75 | 0.57 | 0.41 | 0.45 | 0.69 | 0.92 | 0.98 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.83 | 20.07 | 20.37 | 20.68 | 20.89 | 20.98 | 21.00 | 20.99 | 20.94 | 20.66 | 20.18 | 19.78 | (87) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.90 | 19.90 | 19.90 | 19.91 | 19.92 | 19.93 | 19.93 | 19.93 | 19.92 | 19.92 | 19.91 | 19.91 | (88) |

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.94 | 0.85 | 0.68 | 0.48 | 0.31 | 0.35 | 0.60 | 0.88 | 0.98 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.37 | 18.72 | 19.14 | 19.57 | 19.82 | 19.91 | 19.92 | 19.92 | 19.88 | 19.55 | 18.88 | 18.31 | (90) |

Living area fraction — Living area ÷ (4) = 0.35 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.88 | 19.19 | 19.57 | 19.96 | 20.19 | 20.28 | 20.30 | 20.30 | 20.25 | 19.94 | 19.33 | 18.82 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.88 | 19.19 | 19.57 | 19.96 | 20.19 | 20.28 | 20.30 | 20.30 | 20.25 | 19.94 | 19.33 | 18.82 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | | | | | | | | | | | | | |
| | 0.99 | 0.97 | 0.93 | 0.85 | 0.70 | 0.51 | 0.35 | 0.39 | 0.63 | 0.89 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | | | | | | | | | | | | | |
| | 596.76 | 731.02 | 815.93 | 825.38 | 719.80 | 508.59 | 336.24 | 353.03 | 536.26 | 654.71 | 601.47 | 556.95 | (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] | | | | | | | | | | | | | |
| | 1366.11 | 1336.03 | 1219.34 | 1021.13 | 782.60 | 518.94 | 337.56 | 355.20 | 563.86 | 860.56 | 1131.58 | 1358.39 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | | | | | | | | | | | | | |
| | 572.39 | 406.56 | 300.13 | 140.94 | 46.72 | 0.00 | 0.00 | 0.00 | 0.00 | 153.15 | 381.68 | 596.28 | |

∑(98)1...5, 10...12 = 2597.86 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) 33.95 (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 | | | | | | | | | | | | | |
| | 612.18 | 434.83 | 321.00 | 150.74 | 49.97 | 0.00 | 0.00 | 0.00 | 0.00 | 163.80 | 408.21 | 637.73 | |

∑(211)1...5, 10...12 = 2778.46 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.74 | 87.28 | 86.45 | 84.77 | 82.24 | 79.80 | 79.80 | 79.80 | 79.80 | 84.89 | 87.07 | 87.87 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 200.35 | 177.04 | 186.59 | 168.98 | 169.49 | 154.31 | 146.52 | 163.09 | 163.53 | 175.04 | 182.42 | 194.71 |

∑(219a)1...12 = 2082.08 (219)

**Annual totals**

Space heating fuel - main system 1 — 2778.46

| | | | |
|---|---|---|---|
| Water heating fuel | | 2082.08 | |
| 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) | | 333.80 | (232) |
| Total delivered energy for all uses | (211)...(221) + (231) + (232)...(237b) = | 5269.34 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2778.46 | x | 3.48 | x 0.01 = | 96.69 | (240) |
| Water heating | 2082.08 | x | 3.48 | x 0.01 = | 72.46 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 333.80 | x | 13.19 | x 0.01 = | 44.03 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | (240)...(242) + (245)...(254) = | | 343.07 | (255) |

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

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (256) |
| Energy cost factor (ECF) | 1.19 | (257) |
| SAP value | 83.46 | |
| 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 | 2778.46 | x | 0.216 | = | 600.15 | (261) |
| Water heating | 2082.08 | x | 0.216 | = | 449.73 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 1049.88 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 333.80 | x | 0.519 | = | 173.24 | (268) |
| Total $CO_2$, kg/year | | | (265)...(271) = | | 1262.04 | (272) |
| Dwelling $CO_2$ emission rate | | | (272) ÷ (4) = | | 16.49 | (273) |
| EI value | | | | | 86.08 | |
| 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 | 2778.46 | x | 1.22 | = | 3389.72 | (261) |
| Water heating | 2082.08 | x | 1.22 | = | 2540.14 | (264) |
| Space and water heating | | | (261) + (262) + (263) + (264) = | | 5929.85 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 333.80 | x | 3.07 | = | 1024.77 | (268) |
| Primary energy kWh/year | | | | | 7184.87 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 93.90 | (273) |

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

| | | | |
|---|---|---|---|
| Assessor name | Miss Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A G 04 above gym Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area (m²) | | | Average storey height (m) | | | Volume (m³) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 54.41 | (1a) | x | 3.00 | (2a) | = | 163.23 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 54.41 | (4) | | | | | | |
| Dwelling volume | | | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | 163.23 | (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 | | 4.00 | (17) |
| If based on air permeability value, then (18) = [(17) ÷ 20] + (8), otherwise (18) = (16) | | 0.32 | (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) = | 0.25 | (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 | 0.32 | 0.31 | 0.31 | 0.27 | 0.27 | 0.24 | 0.24 | 0.23 | 0.25 | 0.27 | 0.28 | 0.29 | (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 | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.54 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.54 | (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 | | | 15.56 | x | 1.24 | = | 19.23 | | | (27) |
| Exposed floor | | | 54.41 | x | 0.06 | = | 3.26 | | | (28b |
| External wall | | | 21.39 | x | 0.18 | = | 3.85 | | | (29a) |
| Party wall | | | 76.23 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 91.36 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 26.34 | (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 | | 7.66 | (36) |
| Total fabric heat loss | (33) + (36) = | 34.01 | (37) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ventilation heat loss calculated monthly 0.33 x (25)m x (5) | 29.67 | 29.56 | 29.46 | 28.97 | 28.88 | 28.45 | 28.45 | 28.37 | 28.62 | 28.88 | 29.06 | 29.26 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 63.67 | 63.57 | 63.46 | 62.97 | 62.88 | 62.46 | 62.46 | 62.38 | 62.62 | 62.88 | 63.07 | 63.26 | |

Average = ∑(39)1...12/12 = 62.97 (39)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.17 | 1.17 | 1.17 | 1.16 | 1.16 | 1.15 | 1.15 | 1.15 | 1.15 | 1.16 | 1.16 | 1.16 | |

Average = ∑(40)1...12/12 = 1.16 (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 | 1.82 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 77.43 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 85.17 | 82.07 | 78.97 | 75.88 | 72.78 | 69.68 | 69.68 | 72.78 | 75.88 | 78.97 | 82.07 | 85.17 | |

∑(44)1...12 = 929.11 (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) | 126.30 | 110.47 | 113.99 | 99.38 | 95.36 | 82.29 | 76.25 | 87.50 | 88.54 | 103.19 | 112.64 | 122.32 | |

∑(45)1...12 = 1218.22 (45)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Distribution loss 0.15 x (45)m | 18.95 | 16.57 | 17.10 | 14.91 | 14.30 | 12.34 | 11.44 | 13.12 | 13.28 | 15.48 | 16.90 | 18.35 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (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 | 3.91 | (52) |
| Temperature factor from Table 2b | 1.00 | (53) |
| Energy lost from water storage (kWh/day) (47) x (51) x (52) x (53) | 0.12 | (54) |
| Enter (50) or (54) in (55) | 0.12 | (55) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Water storage loss calculated for each month (55) x (41)m | 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (56) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 3.69 | 3.33 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | 3.69 | 3.57 | 3.69 | 3.57 | 3.69 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 153.25 | 134.81 | 140.94 | 125.46 | 122.31 | 108.36 | 103.20 | 114.45 | 114.62 | 130.14 | 138.72 | 149.27 | (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

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 153.25 | 134.81 | 140.94 | 125.46 | 122.31 | 108.36 | 103.20 | 114.45 | 114.62 | 130.14 | 138.72 | 149.27 |

∑(64)1...12 = 1535.51 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63.55 | 56.20 | 59.46 | 53.91 | 53.26 | 48.22 | 46.91 | 50.65 | 50.30 | 55.87 | 58.32 | 62.23 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 14.14 | 12.56 | 10.22 | 7.74 | 5.78 | 4.88 | 5.27 | 6.86 | 9.20 | 11.68 | 13.64 | 14.54 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 158.66 | 160.31 | 156.16 | 147.33 | 136.18 | 125.70 | 118.70 | 117.05 | 121.20 | 130.03 | 141.18 | 151.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | (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) | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | (71) |
| Water heating gains (Table 5) | 85.42 | 83.63 | 79.92 | 74.87 | 71.59 | 66.98 | 63.05 | 68.08 | 69.87 | 75.09 | 80.99 | 83.64 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 308.53 | 306.81 | 296.60 | 280.24 | 263.85 | 247.86 | 237.33 | 242.29 | 250.57 | 267.11 | 286.12 | 300.14 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthEast | 0.77 | x | 7.78 | x | 36.79 | x 0.9 x | 0.63 | x | 0.80 | = | 99.98 | (77) |
| NorthEast | 0.77 | x | 7.78 | x | 11.28 | x 0.9 x | 0.63 | x | 0.80 | = | 30.66 | (75) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | 130.64 | 232.71 | 345.46 | 473.38 | 571.61 | 585.68 | 557.08 | 481.02 | 389.32 | 264.49 | 158.33 | 110.60 | (83) |
| Total gains - internal and solar (73)m + (83)m | 439.17 | 539.52 | 642.06 | 753.62 | 835.46 | 833.54 | 794.41 | 723.31 | 639.89 | 531.60 | 444.45 | 410.74 | (84) |

## 7. Mean internal temperature (heating season)

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

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

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.94 | 0.84 | 0.66 | 0.47 | 0.34 | 0.39 | 0.64 | 0.91 | 0.98 | 0.99 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.92 | 20.15 | 20.46 | 20.77 | 20.94 | 20.99 | 21.00 | 21.00 | 20.96 | 20.70 | 20.24 | 19.87 | (87) |

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

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

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.97 | 0.93 | 0.80 | 0.60 | 0.40 | 0.26 | 0.31 | 0.56 | 0.87 | 0.98 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.53 | 18.86 | 19.30 | 19.72 | 19.91 | 19.96 | 19.96 | 19.96 | 19.93 | 19.64 | 19.00 | 18.47 | (90) |

Living area fraction — Living area ÷ (4) = 0.53 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.27 | 19.55 | 19.92 | 20.28 | 20.46 | 20.51 | 20.52 | 20.51 | 20.48 | 20.21 | 19.66 | 19.22 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.27 | 19.55 | 19.92 | 20.28 | 20.46 | 20.51 | 20.52 | 20.51 | 20.48 | 20.21 | 19.66 | 19.22 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.97 | 0.93 | 0.81 | 0.63 | 0.44 | 0.31 | 0.35 | 0.60 | 0.88 | 0.97 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 434.04 | 523.79 | 594.38 | 611.75 | 525.44 | 365.62 | 244.08 | 255.77 | 384.73 | 468.87 | 433.23 | 407.14 | (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] | 953.38 | 931.12 | 851.42 | 716.74 | 550.84 | 369.05 | 244.53 | 256.67 | 399.74 | 604.21 | 792.42 | 950.01 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 386.39 | 273.73 | 191.24 | 75.59 | 18.90 | 0.00 | 0.00 | 0.00 | 0.00 | 100.70 | 258.62 | 403.89 | |

∑(98)1...5, 10...12 = 1709.06 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 31.41 (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 | 1709.06 | | | (98) |
| Space heat from boilers | | (98) x (304a) x (305) x (306) = | 1794.51 | (307a) |

**Water heating**

| | | | | |
|---|---|---|---|---|
| Annual water heating requirement | 1535.51 | | | (64) |
| Water heat from boilers | | (64) x (303a) x (305a) x (306) = | 1612.28 | (310a) |
| Electricity used for heat distribution | | 0.01 × [(307a)...(307e) + (310a)...(310e)] = | 34.07 | (313) |

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

| | | |
|---|---|---|
| Total electricity for the above, kWh/year | 0.00 | (331) |
| Electricity for lighting (Appendix L) | 249.81 | (332) |
| Total delivered energy for all uses (307) + (309) + (310) + (312) + (315) + (331) + (332)...(337b) = | 3656.60 | (338) |

## 10b. Fuel costs - community heating scheme

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from boilers | 1794.51 | x | 4.24 | x 0.01 = | 76.09 | (340a) |
| Water heating from boilers | 1612.28 | x | 4.24 | x 0.01 = | 68.36 | (342a) |
| Electricity for lighting | 249.81 | x | 13.19 | x 0.01 = | 32.95 | (350) |
| Additional standing charges | | | | | 120.00 | (351) |
| Total energy cost | | | | (340a)...(342e) + (345)...(354) = | 297.40 | (355) |

## 11b. SAP rating - community heating scheme

| | | |
|---|---|---|
| Energy cost deflator (Table 12) | 0.42 | (356) |
| Energy cost factor (ECF) | 1.26 | (357) |
| SAP value | 82.47 | |
| 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) = | 3806.48 | x | 0.216 | = | 822.20 | (367) |
| Electrical energy for community heat distribution | 34.07 | x | 0.519 | = | 17.68 | (372) |
| Total CO2 associated with community systems | | | | | 839.88 | (373) |
| Total CO2 associated with space and water heating | | | | | 839.88 | (376) |
| Electricity for lighting | 249.81 | x | 0.519 | = | 129.65 | (379) |
| Total $CO_2$, kg/year | | | | (376)..(382) = | 969.53 | (383) |
| Dwelling $CO_2$ emission rate | | | | (383) ÷ (4) = | 17.82 | (384) |
| EI value | | | | | 86.93 | |
| 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) = | 3806.48 | x | 1.22 | = | 4643.91 | (367) |
| Electrical energy for community heat distribution | 34.07 | x | 3.07 | = | 104.59 | (372) |
| Total primary energy associated with community systems | | | | | 4748.49 | (373) |
| Total primary energy associated with space and water heating | | | | | 4748.49 | (376) |
| Electricity for lighting | 249.81 | x | 3.07 | = | 766.90 | (379) |
| Primary energy kWh/year | | | | | 5515.40 | (383) |
| Dwelling primary energy rate kWh/m2/year | | | | | 101.37 | (384) |

# 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 Alicja Kreglewska | Assessor number | 4134 |
| Client | | Last modified | 13/06/2018 |
| Address | A G 04 above gym Ingestre Road, London, NW5 1XE | | |

## 1. Overall dwelling dimensions

| | | Area ($m^2$) | | | Average storey height (m) | | | Volume ($m^3$) | |
|---|---|---|---|---|---|---|---|---|---|
| Lowest occupied | | 54.41 | (1a) | x | 3.00 | (2a) | = | 163.23 | (3a) |
| Total floor area | (1a) + (1b) + (1c) + (1d)...(1n) = | 54.41 | (4) | | | | | | |
| Dwelling volume | | | | | (3a) + (3b) + (3c) + (3d)...(3n) = | | | 163.23 | (5) |

## 2. Ventilation rate

| | | | $m^3$ per hour | |
|---|---|---|---|---|
| Number of chimneys | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | 2 | x 10 = | 20 | (7a) |
| Number of passive vents | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | 0 | x 40 = | 0 | (7c) |
| | | | Air changes per hour | |
| Infiltration due to chimneys, flues, fans, PSVs (6a) + (6b) + (7a) + (7b) + (7c) = | 20 | ÷ (5) = | 0.12 | (8) |

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

| | | | |
|---|---|---|---|
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 5.00 | (17) |
| 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 | | 3 | (19) |
| Shelter factor | 1 - [0.075 x (19)] = | 0.78 | (20) |
| Infiltration rate incorporating shelter factor | (18) x (20) = | 0.29 | (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 | 0.37 | 0.36 | 0.35 | 0.32 | 0.31 | 0.27 | 0.27 | 0.27 | 0.29 | 0.31 | 0.32 | 0.34 | (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 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| d) natural ventilation or whole house positive input ventilation from loft | 0.57 | 0.57 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.55 | 0.56 | (24d) |
| Effective air change rate - enter (24a) or (24b) or (24c) or (24d) in (25) | 0.57 | 0.57 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.55 | 0.56 | (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 | | | 13.61 | x | 1.33 | = | 18.04 | | | (27) |
| Exposed floor | | | 54.41 | x | 0.13 | = | 7.07 | | | (28b |
| External wall | | | 23.35 | x | 0.18 | = | 4.20 | | | (29a) |
| Party wall | | | 76.23 | x | 0.00 | = | 0.00 | | | (32) |
| Total area of external elements ∑A, m² | | | 91.37 | | | | | | | (31) |

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = ∑(A × U) | (26)...(30) + (32) = | 29.32 | (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 | | 4.43 | (36) |
| Total fabric heat loss | (33) + (36) = | 33.75 | (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) | 30.58 | 30.44 | 30.30 | 29.65 | 29.53 | 28.96 | 28.96 | 28.85 | 29.18 | 29.53 | 29.77 | 30.03 | (38) |
| Heat transfer coefficient, W/K (37)m + (38)m | 64.33 | 64.19 | 64.05 | 63.39 | 63.27 | 62.70 | 62.70 | 62.60 | 62.92 | 63.27 | 63.52 | 63.78 | |
| Average = ∑(39)1...12/12 = | | | | | | | | | | | | 63.39 | (39) |
| Heat loss parameter (HLP), W/m²K (39)m ÷ (4) | 1.18 | 1.18 | 1.18 | 1.17 | 1.16 | 1.15 | 1.15 | 1.15 | 1.16 | 1.16 | 1.17 | 1.17 | |
| Average = ∑(40)1...12/12 = | | | | | | | | | | | | 1.17 | (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 | 1.82 | (42) |
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 77.43 | (43) |

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43) | 85.17 | 82.07 | 78.97 | 75.88 | 72.78 | 69.68 | 69.68 | 72.78 | 75.88 | 78.97 | 82.07 | 85.17 | |
| ∑(44)1...12 = | | | | | | | | | | | | 929.11 | (44) |
| Energy content of hot water used = 4.18 x Vd,m x nm x Tm/3600 kWh/month (see Tables 1b, 1c 1d) | 126.30 | 110.47 | 113.99 | 99.38 | 95.36 | 82.29 | 76.25 | 87.50 | 88.54 | 103.19 | 112.64 | 122.32 | |
| ∑(45)1...12 = | | | | | | | | | | | | 1218.22 | (45) |
| Distribution loss 0.15 x (45)m | 18.95 | 16.57 | 17.10 | 14.91 | 14.30 | 12.34 | 11.44 | 13.12 | 13.28 | 15.48 | 16.90 | 18.35 | (46) |

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 2.00 | (47) |
| Water storage loss: | | |
| a) If manufacturer's declared loss factor is known (kWh/day) | 0.24 | (48) |
| Temperature factor from Table 2b | 0.54 | (49) |
| Energy lost from water storage (kWh/day) (48) x (49) | 0.13 | (50) |
| 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 | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (56) |
| If the vessel contains dedicated solar storage or dedicated WWHRS (56)m x [(47) - Vs] ÷ (47), else (56) | 4.00 | 3.61 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | 4.00 | 3.87 | 4.00 | 3.87 | 4.00 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 153.56 | 135.09 | 141.25 | 125.76 | 122.62 | 108.67 | 103.51 | 114.76 | 114.92 | 130.45 | 139.02 | 149.58 | (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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 153.56 | 135.09 | 141.25 | 125.76 | 122.62 | 108.67 | 103.51 | 114.76 | 114.92 | 130.45 | 139.02 | 149.58 | |

∑(64)1...12 = 1539.18 (64)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 63.80 | 56.43 | 59.71 | 54.15 | 53.51 | 48.46 | 47.16 | 50.90 | 50.55 | 56.12 | 58.56 | 62.48 | (65) |

## 5. Internal gains

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Metabolic gains (Table 5) | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | 91.00 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | 14.14 | 12.56 | 10.22 | 7.74 | 5.78 | 4.88 | 5.27 | 6.86 | 9.20 | 11.68 | 13.64 | 14.54 | (67) |
| Appliance gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 158.66 | 160.31 | 156.16 | 147.33 | 136.18 | 125.70 | 118.70 | 117.05 | 121.20 | 130.03 | 141.18 | 151.66 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | 32.10 | (69) |
| Pump and fan gains (Table 5a) | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | 3.00 | (70) |
| Losses e.g. evaporation (Table 5) | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | -72.80 | (71) |
| Water heating gains (Table 5) | 85.76 | 83.97 | 80.26 | 75.21 | 71.93 | 67.31 | 63.39 | 68.42 | 70.20 | 75.43 | 81.33 | 83.98 | (72) |
| Total internal gains (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m | 311.87 | 310.14 | 299.93 | 283.57 | 267.19 | 251.19 | 240.66 | 245.63 | 253.91 | 270.45 | 289.45 | 303.48 | (73) |

## 6. Solar gains

| | Access factor Table 6d | | Area m² | | Solar flux W/m² | | g specific data or Table 6b | | FF specific data or Table 6c | | Gains W | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SouthEast | 0.77 | x | 6.81 | x | 36.79 | x 0.9 x | 0.63 | x | 0.70 | = | 76.58 | (77) |
| NorthEast | 0.77 | x | 6.80 | x | 11.28 | x 0.9 x | 0.63 | x | 0.70 | = | 23.45 | (75) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Solar gains in watts ∑(74)m...(82)m | 100.02 | 178.17 | 264.46 | 362.36 | 437.52 | 448.28 | 426.39 | 368.19 | 298.03 | 202.49 | 121.22 | 84.68 | (83) |
| Total gains - internal and solar (73)m + (83)m | 411.89 | 488.31 | 564.40 | 645.93 | 704.71 | 699.47 | 667.06 | 613.82 | 551.94 | 472.94 | 410.68 | 388.16 | (84) |

## 7. Mean internal temperature (heating season)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains for living area n1,m (see Table 9a) | 0.99 | 0.99 | 0.96 | 0.90 | 0.75 | 0.56 | 0.41 | 0.46 | 0.72 | 0.94 | 0.99 | 1.00 | (86) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.86 | 20.05 | 20.34 | 20.68 | 20.90 | 20.98 | 21.00 | 20.99 | 20.94 | 20.63 | 20.18 | 19.82 | (87) |

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

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

Utilisation factor for gains for rest of dwelling n2,m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.99 | 0.98 | 0.95 | 0.86 | 0.69 | 0.47 | 0.32 | 0.36 | 0.64 | 0.91 | 0.98 | 0.99 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 18.43 | 18.72 | 19.13 | 19.59 | 19.86 | 19.95 | 19.96 | 19.96 | 19.91 | 19.54 | 18.91 | 18.39 | (90) |

Living area fraction — Living area ÷ (4) = 0.53 (91)

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.20 | 19.43 | 19.77 | 20.17 | 20.41 | 20.50 | 20.51 | 20.51 | 20.46 | 20.12 | 19.59 | 19.15 | (92) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 19.20 | 19.43 | 19.77 | 20.17 | 20.41 | 20.50 | 20.51 | 20.51 | 20.46 | 20.12 | 19.59 | 19.15 | (93) |

## 8. Space heating requirement

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, ηm | 0.99 | 0.98 | 0.95 | 0.87 | 0.72 | 0.52 | 0.37 | 0.42 | 0.68 | 0.92 | 0.98 | 0.99 | (94) |
| Useful gains, ηmGm, W (94)m x (84)m | 408.17 | 478.48 | 536.83 | 562.99 | 505.38 | 362.61 | 244.28 | 255.44 | 374.35 | 433.16 | 402.98 | 385.46 | (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] | 958.17 | 932.61 | 850.19 | 714.42 | 551.27 | 369.90 | 245.31 | 257.34 | 400.09 | 602.60 | 793.13 | 953.67 | (97) |
| Space heating requirement, kWh/month 0.024 x [(97)m - (95)m] x (41)m | 409.20 | 305.17 | 233.14 | 109.03 | 34.14 | 0.00 | 0.00 | 0.00 | 0.00 | 126.07 | 280.90 | 422.75 | |

∑(98)1...5, 10...12 = 1920.41 (98)

Space heating requirement kWh/m²/year — (98) ÷ (4) = 35.30 (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 | 437.65 | 326.39 | 249.35 | 116.61 | 36.52 | 0.00 | 0.00 | 0.00 | 0.00 | 134.83 | 300.43 | 452.14 | |

∑(211)1...5, 10...12 = 2053.91 (211)

**Water heating**

Efficiency of water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 87.31 | 86.92 | 86.14 | 84.44 | 81.91 | 79.80 | 79.80 | 79.80 | 79.80 | 84.72 | 86.65 | 87.44 | (217) |

Water heating fuel, kWh/month

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 175.89 | 155.41 | 163.97 | 148.94 | 149.70 | 136.17 | 129.71 | 143.81 | 144.01 | 153.97 | 160.43 | 171.07 |

∑(219a)1...12 = 1833.10 (219)

**Annual totals**

Space heating fuel - main system 1 — 2053.91

| | | | | | | |
|---|---|---|---|---|---|---|
| Water heating fuel | | | | | 1833.10 | |
| Electricity for pumps, fans and electric keep-hot (Table 4f) | | | | | | |
| central heating pump or water pump within warm air heating unit | | | 30.00 | | | (230c) |
| boiler flue fan | | | 45.00 | | | (230e) |
| Total electricity for the above, kWh/year | | | | | 75.00 | (231) |
| Electricity for lighting (Appendix L) | | | | | 249.81 | (232) |
| Total delivered energy for all uses | | | | (211)...(221) + (231) + (232)...(237b) = | 4211.81 | (238) |

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

| | Fuel kWh/year | | Fuel price | | Fuel cost £/year | |
|---|---|---|---|---|---|---|
| Space heating - main system 1 | 2053.91 | x | 3.48 | x 0.01 = | 71.48 | (240) |
| Water heating | 1833.10 | x | 3.48 | x 0.01 = | 63.79 | (247) |
| Pumps and fans | 75.00 | x | 13.19 | x 0.01 = | 9.89 | (249) |
| Electricity for lighting | 249.81 | x | 13.19 | x 0.01 = | 32.95 | (250) |
| Additional standing charges | | | | | 120.00 | (251) |
| Total energy cost | | | | (240)...(242) + (245)...(254) = | 298.11 | (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 | 82.43 | |
| 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 | 2053.91 | x | 0.216 | = | 443.64 | (261) |
| Water heating | 1833.10 | x | 0.216 | = | 395.95 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 839.59 | (265) |
| Pumps and fans | 75.00 | x | 0.519 | = | 38.93 | (267) |
| Electricity for lighting | 249.81 | x | 0.519 | = | 129.65 | (268) |
| Total $CO_2$, kg/year | | | | (265)...(271) = | 1008.17 | (272) |
| Dwelling $CO_2$ emission rate | | | | (272) ÷ (4) = | 18.53 | (273) |
| EI value | | | | | 86.41 | |
| 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 | 2053.91 | x | 1.22 | = | 2505.77 | (261) |
| Water heating | 1833.10 | x | 1.22 | = | 2236.38 | (264) |
| Space and water heating | | | | (261) + (262) + (263) + (264) = | 4742.15 | (265) |
| Pumps and fans | 75.00 | x | 3.07 | = | 230.25 | (267) |
| Electricity for lighting | 249.81 | x | 3.07 | = | 766.90 | (268) |
| Primary energy kWh/year | | | | | 5739.30 | (272) |
| Dwelling primary energy rate kWh/m2/year | | | | | 105.48 | (273) |

# APPENDIX B

# BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

**Project name**

# Assisted Living Development

As designed

**Date: Thu Jun 28 10:47:24 2018**

## Administrative information

### Building Details

**Address:** 12 Ingestre Road, Address 2, London, NW5 1XE

### Certification tool

**Calculation engine:** SBEM

**Calculation engine version:** v5.4.a.1

**Interface to calculation engine:** Virtual Environment

**Interface to calculation engine version:** v7.0.9

**BRUKL compliance check version:** v5.4.a.1

### Owner Details

**Name:** Available upon request

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

### Certifier details

**Name:** Alicja Kreglewska

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

## 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 | 31.7 |
| Target $CO_2$ emission rate (TER), $kgCO_2/m^2$.annum | 31.7 |
| Building $CO_2$ emission rate (BER), $kgCO_2/m^2$.annum | 30.4 |
| 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 | $U_{a-Limit}$ | $U_{a-Calc}$ | $U_{i-Calc}$ | Surface where the maximum value occurs* |
|---|---|---|---|---|
| Wall** | 0.35 | 0.18 | 0.18 | BS000003_W1 |
| Floor | 0.25 | 0.16 | 0.22 | BS000009_F |
| Roof | 0.25 | 0.1 | 0.1 | BS000003_C |
| Windows***, roof windows, and rooflights | 2.2 | 1.37 | 1.41 | BS000009_W1_O0 |
| Personnel doors | 2.2 | 1.4 | 1.4 | 1S000006_W3_O0 |
| Vehicle access & similar large doors | 1.5 | 0.41 | 0.41 | GF00000A_W1_O0 |
| High usage entrance doors | 3.5 | - | - | "No external high usage entrance doors" |

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]

$U_{a-Calc}$ = Calculated area-weighted average U-values [W/(m²K)]

$U_{i-Calc}$ = 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 |
|---|---|---|
| m³/(h.m²) at 50 Pa | 10 | 4 |

## 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 | >0.95 |

1- ASHP heating/cooling/mech vent

| | Heating efficiency | Cooling efficiency | Radiant efficiency | SFP [W/(l/s)] | HR efficiency |
|---|---|---|---|---|---|
| This system | 3.5 | 5 | - | - | - |
| Standard value | 2.5* | 2.6 | N/A | N/A | N/A |
| Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system | | | | | YES |

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

2- No heating - ventilation only

| | Heating efficiency | Cooling efficiency | Radiant efficiency | SFP [W/(l/s)] | HR efficiency |
|---|---|---|---|---|---|
| This system | 0.91 | - | - | - | - |
| 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 | | | | | YES |

* 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.

3- ASHP gas heated/mech vent

| | Heating efficiency | Cooling efficiency | Radiant efficiency | SFP [W/(l/s)] | HR efficiency |
|---|---|---|---|---|---|
| This system | 3.5 | - | - | - | - |
| Standard value | 2.5* | N/A | N/A | N/A | N/A |
| Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system | | | | | YES |

* Standard shown is for all types >12 kW output, except absorption and gas engine heat pumps. For types <=12 kW output, refer to EN 14825 for limiting standards.

1- SYST0002-DHW

| | Water heating efficiency | Storage loss factor [kWh/litre per day] |
|---|---|---|
| This building | Hot water provided by HVAC system | 0.012 |
| Standard value | N/A | N/A |

2- SYST0003-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 |

3- SYST0000-DHW

| | Water heating efficiency | Storage loss factor [kWh/litre per day] |
|---|---|---|
| This building | Hot water provided by HVAC system | 0.01 |
| 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 |
| Gym | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Classes | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Hairdressers | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF hobby rooms | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 1st floor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Residents Lounge - no nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Residents Lounge - nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Reception - nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Reception - no nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Cafe - nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Cafe - no nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Laundry store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Plant store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Refuse | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Bar store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF cycle store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF car lift | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Plant store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Cycle and scooter store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Car park | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Kitchen store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Laundry store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Staircase | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Changing rooms | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Toilets | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Corridor to gym | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Staircase | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Toilet & changing rooms | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF staircase | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF toilets to lounge | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |

| 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 |
| GF Guest accomm. | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Guest Accomm | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Commercial kitchen | 0.3 | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF staircase | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Staff facilities | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| staff office | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 1st floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 1st floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 2nd floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 2nd floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 3rd floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 3rd floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 4th floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 4th floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 5th floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 5th floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF toilets to cafe | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF toilet to reception | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |

General lighting and display lighting

| Zone name | Luminous efficacy [lm/W] | | | General lighting [W] |
|---|---|---|---|---|
| | Luminaire | Lamp | Display lamp | |
| Standard value | 60 | 60 | 22 | |
| Gym | - | 100 | - | 441 |
| Classes | - | 100 | - | 340 |
| GF Hairdressers | - | 100 | 30 | 764 |
| GF hobby rooms | 50 | - | - | 749 |
| 1st floor | 50 | - | - | 2559 |
| GF Residents Lounge - no nat light | - | 100 | - | 555 |
| GF Residents Lounge - nat light | - | 100 | - | 386 |
| GF Reception - nat light | - | 100 | 30 | 705 |
| GF Reception - no nat light | - | 100 | 30 | 1033 |
| GF Cafe - nat light | - | 100 | - | 194 |
| GF Cafe - no nat light | - | 100 | - | 166 |
| Laundry store | - | 100 | - | 395 |
| Plant store | 50 | - | - | 264 |
| Refuse | 50 | - | - | 331 |
| GF Bar store | 50 | - | - | 83 |
| GF cycle store | 50 | - | - | 177 |
| GF car lift | - | 100 | - | 123 |

| General lighting and display lighting | Luminous efficacy [lm/W] | | | |
|---|---|---|---|---|
| Zone name | Luminaire | Lamp | Display lamp | General lighting [W] |
| Standard value | 60 | 60 | 22 | |
| Plant store | 50 | - | - | 297 |
| Cycle and scooter store | 50 | - | - | 712 |
| Car park | - | 100 | - | 1503 |
| Kitchen store | 50 | - | - | 76 |
| Laundry store | - | 100 | - | 439 |
| Staircase | - | 100 | - | 75 |
| Changing rooms | - | 100 | - | 39 |
| Toilets | - | 100 | - | 39 |
| Corridor to gym | - | 100 | - | 56 |
| Staircase | - | 100 | - | 74 |
| Toilet & changing rooms | - | 100 | - | 69 |
| Access corridor | - | 100 | - | 111 |
| GF staircase | - | 100 | - | 77 |
| GF toilets to lounge | - | 100 | - | 299 |
| GF Guest accomm. | - | 100 | - | 109 |
| GF Guest Accomm | - | 100 | - | 110 |
| GF Commercial kitchen | - | 100 | - | 359 |
| GF staircase | - | 100 | - | 78 |
| GF access corridor | - | 100 | - | 253 |
| GF Staff facilities | 50 | - | - | 523 |
| Access corridor | - | 100 | - | 97 |
| staff office | 50 | - | - | 186 |
| 1st floor access corridor | - | 100 | - | 236 |
| 1st floor access corridor | - | 100 | - | 232 |
| 2nd floor access corridor | - | 100 | - | 252 |
| 2nd floor access corridor | - | 100 | - | 253 |
| 3rd floor access corridor | - | 100 | - | 251 |
| 3rd floor access corridor | - | 100 | - | 252 |
| 4th floor access corridor | - | 100 | - | 249 |
| 4th floor access corridor | - | 100 | - | 251 |
| 5th floor access corridor | - | 100 | - | 232 |
| 5th floor access corridor | - | 100 | - | 235 |
| GF toilets to cafe | - | 100 | - | 132 |
| GF toilet to reception | - | 100 | - | 66 |
| GF access corridor | - | 100 | - | 299 |
| Access corridor | - | 100 | - | 176 |

## 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? |
|---|---|---|
| Gym | N/A | N/A |
| Classes | NO (-79.3%) | NO |
| GF Hairdressers | NO (-77.2%) | NO |
| GF hobby rooms | N/A | N/A |

| Zone | Solar gain limit exceeded? (%) | Internal blinds used? |
|---|---|---|
| 1st floor | NO (-55.1%) | NO |
| GF Residents Lounge - no nat light | N/A | N/A |
| GF Residents Lounge - nat light | YES (+29.2%) | NO |
| GF Reception - nat light | N/A | N/A |
| GF Reception - no nat light | N/A | N/A |
| GF Cafe - nat light | N/A | N/A |
| GF Cafe - no nat light | N/A | N/A |
| GF Guest accomm. | NO (-77.3%) | NO |
| GF Guest Accomm | NO (-77.7%) | NO |
| GF Staff facilities | N/A | N/A |
| staff office | N/A | N/A |

## 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?** | YES |
| Is evidence of such assessment available as a separate submission? | YES |
| Are any such measures included in the proposed design? | YES |

# Technical Data Sheet (Actual vs. Notional Building)

## Building Global Parameters

| | Actual | Notional |
|---|---|---|
| Area [m²] | 3558.1 | 3558.1 |
| External area [m²] | 3319.6 | 3319.6 |
| Weather | LON | LON |
| Infiltration [m³/hm²@ 50Pa] | 4 | 3 |
| Average conductance [W/K] | 819.38 | 1276.69 |
| Average U-value [W/m²K] | 0.25 | 0.38 |
| Alpha value* [%] | 21.67 | 13.3 |

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

## Building Use

| % Area | Building Type |
|---|---|
| 1 | **A1/A2 Retail/Financial and Professional services** |
| | A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways |
| 17 | **B1 Offices and Workshop businesses** |
| | B2 to B7 General Industrial and Special Industrial Groups |
| | B8 Storage or Distribution |
| 2 | **C1 Hotels** |
| 67 | **C2 Residential Institutions: Hospitals and Care Homes** |
| | C2 Residential Institutions: Residential schools |
| | C2 Residential Institutions: Universities and colleges |
| | C2A Secure Residential Institutions |
| | Residential spaces |
| 7 | **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 |
| 6 | **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/m²]

| | Actual | Notional |
|---|---|---|
| Heating | 0.28 | 1.8 |
| Cooling | 9.88 | 5.85 |
| Auxiliary | 7.04 | 8.63 |
| Lighting | 22.79 | 21.07 |
| Hot water | 20.14 | 25.53 |
| Equipment* | 56.35 | 56.35 |
| **TOTAL**** | 60.13 | 62.88 |

* 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/m²]

| | 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/m²] | 222.85 | 192.84 |
| Primary energy* [kWh/m²] | 179.93 | 187.78 |
| Total emissions [kg/m²] | 30.4 | 31.7 |

* 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] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity | | | | | | | | | | |
| | Actual | 6.1 | 424.1 | 0.5 | 36.7 | 7.7 | 3.43 | 3.21 | 3.5 | 4.3 |
| | Notional | 15.7 | 281.4 | 1.8 | 21.7 | 10.9 | 2.43 | 3.6 | ---- | ---- |
| [ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity | | | | | | | | | | |
| | Actual | 0.2 | 80.3 | 0.1 | 0 | 2.5 | 0.86 | 0 | 0.91 | 0 |
| | Notional | 2.3 | 54.6 | 0.8 | 0 | 2.8 | 0.82 | 0 | ---- | ---- |
| [ST] Central heating using water: radiators, [HS] Heat pump (electric): air source, [HFT] Electricity, [CFT] Electricity | | | | | | | | | | |
| | Actual | 3.4 | 192.6 | 0.3 | 0 | 10 | 3.29 | 0 | 3.5 | 0 |
| | Notional | 22.5 | 205.4 | 2.6 | 0 | 11.6 | 2.43 | 0 | ---- | ---- |

## 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 | 0.18 | BS000003_W1 |
| Floor | 0.2 | 0.12 | 1S000006_F |
| Roof | 0.15 | 0.1 | BS000003_C |
| Windows, roof windows, and rooflights | 1.5 | 1 | BS000010_C_O0 |
| Personnel doors | 1.5 | 1.4 | GF000000_W1_O0 |
| Vehicle access & similar large doors | 1.5 | 0.41 | GF00000A_W1_O0 |
| 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 |
|---|---|---|
| m³/(h.m²) at 50 Pa | 5 | 4 |

# BRUKL Output Document

HM Government

Compliance with England Building Regulations Part L 2013

**Project name**

## Assisted Living Development

As designed

**Date: Thu Jun 28 09:51:41 2018**

## Administrative information

### Building Details

**Address:** 12 Ingestre Road, Address 2, London, NW5 1XE

### Certification tool

**Calculation engine:** SBEM

**Calculation engine version:** v5.4.a.1

**Interface to calculation engine:** Virtual Environment

**Interface to calculation engine version:** v7.0.9

**BRUKL compliance check version:** v5.4.a.1

### Owner Details

**Name:** Available upon request

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

### Certifier details

**Name:** Alicja Kreglewska

**Telephone number:** Phone

**Address:** Street Address, City, Postcode

## Criterion 1: The calculated $CO_2$ emission rate for the building must not exceed the target

The building does not comply with England Building Regulations Part L 2013

| | |
|---|---|
| $CO_2$ emission rate from the notional building, $kgCO_2/m^2$.annum | 35.1 |
| Target $CO_2$ emission rate (TER), $kgCO_2/m^2$.annum | 35.1 |
| Building $CO_2$ emission rate (BER), $kgCO_2/m^2$.annum | 36.8 |
| 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 | $U_{a-Limit}$ | $U_{a-Calc}$ | $U_{i-Calc}$ | Surface where the maximum value occurs* |
|---|---|---|---|---|
| Wall** | 0.35 | 0.18 | 0.18 | BS000003_W1 |
| Floor | 0.25 | 0.16 | 0.22 | BS000009_F |
| Roof | 0.25 | 0.1 | 0.1 | BS000003_C |
| Windows***, roof windows, and rooflights | 2.2 | 1.37 | 1.41 | BS000009_W1_O0 |
| Personnel doors | 2.2 | 1.4 | 1.4 | 1S000006_W3_O0 |
| Vehicle access & similar large doors | 1.5 | 0.41 | 0.41 | GF00000A_W1_O0 |
| High usage entrance doors | 3.5 | - | - | "No external high usage entrance doors" |

$U_{a-Limit}$ = Limiting area-weighted average U-values [W/(m²K)]

$U_{a-Calc}$ = Calculated area-weighted average U-values [W/(m²K)]

$U_{i-Calc}$ = 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 | 4 |

## 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 | >0.95 |

1- Base case - gas heating/cooling/mech vent

| | Heating efficiency | Cooling efficiency | Radiant efficiency | SFP [W/(l/s)] | HR efficiency |
|---|---|---|---|---|---|
| This system | 0.91 | 5 | - | - | - |
| Standard value | 0.91* | 2.6 | N/A | N/A | N/A |
| Automatic monitoring & targeting with alarms for out-of-range values for this HVAC system | | | | | YES |

* 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.

2- No heating - ventilation only

| | Heating efficiency | Cooling efficiency | Radiant efficiency | SFP [W/(l/s)] | HR efficiency |
|---|---|---|---|---|---|
| This system | 0.91 | - | - | - | - |
| 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 | | | | | YES |

* 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.

3- Base case - gas heated/mech vent

| | Heating efficiency | Cooling efficiency | Radiant efficiency | SFP [W/(l/s)] | HR efficiency |
|---|---|---|---|---|---|
| This system | 0.91 | - | - | - | - |
| 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 | | | | | YES |

* 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- SYST0002-DHW

| | Water heating efficiency | Storage loss factor [kWh/litre per day] |
|---|---|---|
| This building | Hot water provided by HVAC system | 0.012 |
| Standard value | N/A | N/A |

2- SYST0003-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 |

3- SYST0000-DHW

| | Water heating efficiency | Storage loss factor [kWh/litre per day] |
|---|---|---|
| This building | Hot water provided by HVAC system | 0.01 |
| 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 |
| Gym | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Classes | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Hairdressers | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF hobby rooms | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 1st floor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Residents Lounge - no nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Residents Lounge - nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Reception - nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Reception - no nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Cafe - nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Cafe - no nat light | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Laundry store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Plant store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Refuse | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Bar store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF cycle store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF car lift | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Plant store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Cycle and scooter store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Car park | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Kitchen store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Laundry store | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Staircase | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Changing rooms | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Toilets | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Corridor to gym | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Staircase | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Toilet & changing rooms | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF staircase | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF toilets to lounge | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |

| 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 |
| GF Guest accomm. | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Guest Accomm | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Commercial kitchen | 0.3 | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF staircase | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF Staff facilities | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| staff office | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 1st floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 1st floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 2nd floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 2nd floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 3rd floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 3rd floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 4th floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 4th floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 5th floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| 5th floor access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF toilets to cafe | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF toilet to reception | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| GF access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 0.5 |
| Access corridor | - | - | - | 0.5 | - | - | - | - | - | 0.8 | 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 | |
| Gym | - | 100 | - | 441 |
| Classes | - | 100 | - | 340 |
| GF Hairdressers | - | 100 | 30 | 764 |
| GF hobby rooms | - | 100 | - | 449 |
| 1st floor | - | 100 | - | 1535 |
| GF Residents Lounge - no nat light | - | 100 | - | 555 |
| GF Residents Lounge - nat light | - | 100 | - | 386 |
| GF Reception - nat light | - | 100 | 30 | 705 |
| GF Reception - no nat light | - | 100 | 30 | 1033 |
| GF Cafe - nat light | - | 100 | - | 194 |
| GF Cafe - no nat light | - | 100 | - | 166 |
| Laundry store | - | 100 | - | 395 |
| Plant store | 50 | - | - | 264 |
| Refuse | 50 | - | - | 331 |
| GF Bar store | 50 | - | - | 83 |
| GF cycle store | 50 | - | - | 177 |
| GF car lift | - | 100 | - | 123 |

| General lighting and display lighting | Luminous efficacy [lm/W] | | | |
|---|---|---|---|---|
| Zone name | Luminaire | Lamp | Display lamp | General lighting [W] |
| Standard value | 60 | 60 | 22 | |
| Plant store | 50 | - | - | 297 |
| Cycle and scooter store | 50 | - | - | 712 |
| Car park | - | 100 | - | 1503 |
| Kitchen store | 50 | - | - | 76 |
| Laundry store | - | 100 | - | 439 |
| Staircase | - | 100 | - | 75 |
| Changing rooms | - | 100 | - | 39 |
| Toilets | - | 100 | - | 39 |
| Corridor to gym | - | 100 | - | 56 |
| Staircase | - | 100 | - | 74 |
| Toilet & changing rooms | - | 100 | - | 69 |
| Access corridor | - | 100 | - | 111 |
| GF staircase | - | 100 | - | 77 |
| GF toilets to lounge | - | 100 | - | 299 |
| GF Guest accomm. | - | 100 | - | 109 |
| GF Guest Accomm | - | 100 | - | 110 |
| GF Commercial kitchen | - | 100 | - | 359 |
| GF staircase | - | 100 | - | 78 |
| GF access corridor | - | 100 | - | 253 |
| GF Staff facilities | 50 | - | - | 523 |
| Access corridor | - | 100 | - | 97 |
| staff office | 50 | - | - | 186 |
| 1st floor access corridor | - | 100 | - | 236 |
| 1st floor access corridor | - | 100 | - | 232 |
| 2nd floor access corridor | - | 100 | - | 252 |
| 2nd floor access corridor | - | 100 | - | 253 |
| 3rd floor access corridor | - | 100 | - | 251 |
| 3rd floor access corridor | - | 100 | - | 252 |
| 4th floor access corridor | - | 100 | - | 249 |
| 4th floor access corridor | - | 100 | - | 251 |
| 5th floor access corridor | - | 100 | - | 232 |
| 5th floor access corridor | - | 100 | - | 235 |
| GF toilets to cafe | - | 100 | - | 132 |
| GF toilet to reception | - | 100 | - | 66 |
| GF access corridor | - | 100 | - | 299 |
| Access corridor | - | 100 | - | 176 |

## 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? |
|---|---|---|
| Gym | N/A | N/A |
| Classes | NO (-79.3%) | NO |
| GF Hairdressers | NO (-77.2%) | NO |
| GF hobby rooms | N/A | N/A |

| Zone | Solar gain limit exceeded? (%) | Internal blinds used? |
|---|---|---|
| 1st floor | NO (-55.1%) | NO |
| GF Residents Lounge - no nat light | N/A | N/A |
| GF Residents Lounge - nat light | YES (+29.2%) | NO |
| GF Reception - nat light | N/A | N/A |
| GF Reception - no nat light | N/A | N/A |
| GF Cafe - nat light | N/A | N/A |
| GF Cafe - no nat light | N/A | N/A |
| GF Guest accomm. | NO (-77.3%) | NO |
| GF Guest Accomm | NO (-77.7%) | NO |
| GF Staff facilities | N/A | N/A |
| staff office | N/A | N/A |

## 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?** | YES |
| Is evidence of such assessment available as a separate submission? | YES |
| Are any such measures included in the proposed design? | YES |

# Technical Data Sheet (Actual vs. Notional Building)

## Building Global Parameters

| | Actual | Notional |
|---|---|---|
| Area [m²] | 3558.1 | 3558.1 |
| External area [m²] | 3319.6 | 3319.6 |
| Weather | LON | LON |
| Infiltration [m³/hm²@ 50Pa] | 4 | 3 |
| Average conductance [W/K] | 819.38 | 1276.69 |
| Average U-value [W/m²K] | 0.25 | 0.38 |
| Alpha value* [%] | 21.67 | 13.3 |

* Percentage of the building's average heat transfer coefficient which is due to thermal bridging

## Building Use

| % Area | Building Type |
|---|---|
| 1 | **A1/A2 Retail/Financial and Professional services** |
| | A3/A4/A5 Restaurants and Cafes/Drinking Est./Takeaways |
| 17 | **B1 Offices and Workshop businesses** |
| | B2 to B7 General Industrial and Special Industrial Groups |
| | B8 Storage or Distribution |
| 2 | **C1 Hotels** |
| 67 | **C2 Residential Institutions: Hospitals and Care Homes** |
| | C2 Residential Institutions: Residential schools |
| | C2 Residential Institutions: Universities and colleges |
| | C2A Secure Residential Institutions |
| | Residential spaces |
| 7 | **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 |
| 6 | **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/m²]

| | Actual | Notional |
|---|---|---|
| Heating | 1.29 | 5.18 |
| Cooling | 10.33 | 6.22 |
| Auxiliary | 7.13 | 8.69 |
| Lighting | 21.84 | 20.23 |
| Hot water | 76.85 | 75.13 |
| Equipment* | 55.64 | 55.64 |
| **TOTAL**** | 117.45 | 115.45 |

* 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/m²]

| | 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/m²] | 229.03 | 198.53 |
| Primary energy* [kWh/m²] | 212.97 | 203.15 |
| Total emissions [kg/m²] | 36.8 | 35.1 |

* 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 | 9.6 | 443.6 | 3 | 38.3 | 8.1 | 0.89 | 3.21 | 0.91 | 4.3 |
| | Notional | 19.3 | 298.9 | 6.5 | 23.1 | 11.2 | 0.82 | 3.6 | ---- | ---- |
| [ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity | | | | | | | | | | |
| | Actual | 0.2 | 80.3 | 0.1 | 0 | 2.5 | 0.86 | 0 | 0.91 | 0 |
| | Notional | 2.3 | 54.6 | 0.8 | 0 | 2.8 | 0.82 | 0 | ---- | ---- |
| [ST] Central heating using water: radiators, [HS] LTHW boiler, [HFT] Natural Gas, [CFT] Electricity | | | | | | | | | | |
| | Actual | 3.4 | 192.6 | 1.1 | 0 | 10 | 0.86 | 0 | 0.91 | 0 |
| | Notional | 22.5 | 205.4 | 7.6 | 0 | 11.5 | 0.82 | 0 | ---- | ---- |

## 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 | 0.18 | BS000003_W1 |
| Floor | 0.2 | 0.12 | 1S000006_F |
| Roof | 0.15 | 0.1 | BS000003_C |
| Windows, roof windows, and rooflights | 1.5 | 1 | BS000010_C_O0 |
| Personnel doors | 1.5 | 1.4 | GF000000_W1_O0 |
| Vehicle access & similar large doors | 1.5 | 0.41 | GF00000A_W1_O0 |
| 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 |
|---|---|---|
| m³/(h.m²) at 50 Pa | 5 | 4 |