



## Energy Statement

Ryeland, Trevanna Cross, St. Mawgan TR8 4HB

Mr And Mrs Bawden

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## 1. ASSESSMENT INFORMATION

|                            |  |
|----------------------------|--|
| <b>Project Name</b>        | Ryeland  |
| <b>Project Address</b>     | Ryeland, Trevanna Cross, St. Mawgan TR8 4HB                                |
| <b>Developer</b>           | Mr and Mrs Bawden  |
| <b>Developer Address</b>   | Ryeland, Trevanna Cross, St Mawgan TR8 4HB                                 |
| <b>Architect</b>           | ARK Architecture   |
| <b>Architect's Address</b> | 25 Sweet Briar Crescent, Newquay   |
| <b>Project Description</b> | Construction of 2 new dwellings and associated carparking and landscaping. |

|             | Author | Date     | Email Address                      |
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| Reviewed by | MF     | 21/12/23 |                                    |

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| 01           | MH     | 21/12/23 | Initial Issue |
| 02           |        |          |               |
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| 04           |        |          |               |

This document has been prepared for Mr and Mrs Bawden only and solely for the purposes expressly defined herein. We owe no duty of care to any third parties in respect of its content. Therefore, unless expressly agreed by us in signed writing, we hereby exclude all liability to third parties, including liability for negligence, save only for liabilities that cannot be so excluded by operation of applicable law. The consequences of climate change and the effects of future changes in climatic conditions cannot be accurately predicted. This report has been based solely on the specific design assumptions and criteria stated herein.

## 2. EXECUTIVE SUMMARY

This document has been prepared by Abbey Consultants (Southern) Ltd, a specialist environmental and energy consultancy on behalf, to accompany a full planning application for the provision of 2 new residential dwellings at Ryeland, Trevanna Cross, St. Mawgan TR8 4HB

The proposed strategy has been based around the relevant objectives of Cornwall Council's Climate Emergency Development Plan Document, namely policy SEC1 (renewable energy). This report considers sustainability and includes an assessment of the predicted energy and CO<sub>2</sub> demand for the proposed development. In the formulation of this strategy, much consideration has been given to minimising the carbon emissions of the proposed development, and to ensure the development is constructed to rigorous sustainability standards.

In keeping with the requirements of Cornwall Council's, this report comprises of the following:

- A Building Regulation baseline energy assessment for the proposed development.
- Energy conservation measures to be undertaken in the design of the development.
- A calculation of CO<sub>2</sub> savings that are to be achieved as a result of energy efficiency measures.
- An appraisal of the potential options for on-site renewables or low and zero carbon technologies.
- An outline specification of the proposed water efficiency measures to limit the internal water usage of each dwelling to less than 110 litres per person per day.

The proposed development will be built to Part L 2021 of the Building Regulations.

The energy strategy detailed herein shows that the development will first reduce regulated CO<sub>2</sub> emissions by integrating a range of passive design and energy efficiency measures throughout the building. These measures include significantly improving building fabric standards beyond the requirements of Part L of the Building Regulations. Considerable emphasis has been placed on utilising passive design measures and targeting fabric efficiency in order to mitigate energy use. Homeowners will therefore be provided with a comfortable, efficient and cost-effective dwelling. These measures enable the proposed

scheme to go beyond Target Emission Rates (TER) and Target Fabric Energy Efficiency (TFEE) minimum standards via energy efficiency measures alone.

Following reduction of the energy demand through fabric and energy efficiency improvements, individual highly efficient air source heat pumps have been proposed to supply hot water and space heating to all dwellings. In an effort to limit CO<sub>2</sub> emissions further, a proposal for an estimated 7.2 kWp of PV cells across the development has been specified.

The table below demonstrates that the energy strategy detailed herein will achieve an estimated carbon emissions reduction of 97% compared to a Part L1 2021 baseline.

**Table 1: Energy Strategy Carbon Emissions Summary**

| Stage of Energy Hierarchy | Regulated CO <sub>2</sub> Emissions (tonnes/year) |
|---------------------------|---|
| Total Baseline            | 2.7   |
| Total After 'Be Lean'     | 1.7   |
| Total After 'Be Green'    | -0.1  |
| <b>Total Saving</b>       | <b>2.80</b>                                       |
| <b>Total Improvement</b>  | <b>104%</b>                                       |

In addition to the above, Policy SEC1 part 2b stipulates three main performance requirements for new residential developments. The energy strategy has been developed around these performance requirements to ensure compliance will be met. The requirements, along with the results for each plot, have been summarised in the below table.

**Table 2: Results Summary of Policy SEC1 part 2b requirements**

| Policy SEC1 Part 2b | Space Heat Demand<br>kWh/m <sup>2</sup> /annum | Total Energy Consumption<br>kWh/m <sup>2</sup> /annum | On-site Renewable Generation<br>% of Total Energy |
|---------------------|--|---|---|
| Required Values:    | < 30   | < 40  | 100%  |
| Plot 1              | 27.8   | 29.9  | 102%  |
| Plot 2              | 29.6   | 26.6  | 110%  |

As can be seen in the above table, both plots are demonstrating compliance with all three of the main performance criteria required by Cornwall Council within their Policy SEC1 part 2b.

A strategy of water saving measures has also been detailed herein, which includes a specification to limit the water usage of the dwellings to 110 litres/person/day. This adheres to the target as set out by Cornwall Council within their Policy SEC1 part 5 of the Climate Emergency Development Plan Document.

### 3. INTRODUCTION

This document has been prepared by Abbey Consultants (Southern) Ltd, a specialist environmental and energy consultancy on behalf of Mr and Mrs Bawden.

The following report establishes a baseline assessment of the energy demands and associated CO<sub>2</sub> emissions for the development. The energy hierarchy approach of Be Lean, Be Clean and Be Green is then followed to ensure the maximum viable reductions in energy and regulated CO<sub>2</sub> emissions is achieved.

The proposed development is described as:

Construction of 2 new dwellings and associated carparking and landscaping.

The report takes into consideration the layout, use and requirements for the development to recommend a strategy that integrates the most suitable technologies available that are commercially viable, whilst also adhering to the requirements of the national and local planning policies.

Figure 1 presents the proposed site layout.

**Figure 1: Site Plan**



## 4. PLANNING POLICY

An effective planning system is required to contribute to achieving sustainable development.

Sustainable development is defined as having the following 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.

1. Economic objective – to help build a strong, responsive and competitive economy, by ensuring that sufficient land of the right types is available in the right places and at the right time to support growth, innovation and improved productivity; and by identifying and coordinating the provision of infrastructure;
2. Social objective – to support strong, vibrant and healthy communities, by ensuring that a sufficient number and range of homes can be provided to meet the needs of present and future generations; and by fostering a well-designed and safe built environment, with accessible services and open spaces that reflect current and future needs and support communities' health, social and cultural well-being; and
3. Environmental objective – to contribute to protecting and enhancing our natural, built and historic environment; including making effective use of land, helping to improve biodiversity, using natural resources prudently, minimising waste and pollution, and mitigating and adapting to climate change, including moving to a low carbon economy.

### 4.1 NATIONAL PLANNING POLICY FRAMEWORK (NPPF) 2021

The NPPF sets out the Government's planning policies for England and how these are expected to be applied. It sets out the Government's requirements for the planning system only to the extent that it is relevant, proportionate and necessary to do so. It provides a framework within which local people and their accountable councils can produce their own distinctive local and neighbourhood plans, which reflect the needs and priorities of their communities.

#### **Chapter 14 Meeting the challenge of climate change, flooding and coastal change**

The following paragraphs set out the Government's position in response to reducing carbon emissions:

Paragraph 154: New development should be planned for in ways that:

- a. avoid increased vulnerability to the range of impacts arising from climate change. When new development is brought forward in areas which are vulnerable, care should be taken to ensure that risks can be managed through suitable adaptation measures, including through the planning of green infrastructure; and
- b. can help to reduce greenhouse gas emissions, such as through its location, orientation and design. Any local requirements for the sustainability of buildings should reflect the Government's policy for national technical standards.

Paragraph 155. To help increase the use and supply of renewable and low carbon energy and heat, plans should:

- a. provide a positive strategy for energy from these sources, that maximises the potential for suitable development, while ensuring that adverse impacts are addressed satisfactorily (including cumulative landscape and visual impacts);
- b. consider identifying suitable areas for renewable and low carbon energy sources, and supporting infrastructure, where this would help secure their development; and
- c. identify opportunities for development to draw its energy supply from decentralised, renewable, or low carbon energy supply systems and for co-locating potential heat customers and suppliers.

Paragraph 157: In determining planning applications, local planning authorities should expect new development to:

- a. comply with adopted Local Plan policies on local requirements for decentralised energy supply unless it can be demonstrated by the applicant, having regard to the type of development involved and its design, that this is not feasible or viable; and
- b. take account of landform, layout, building orientation, massing and landscaping to minimise energy consumption.

Paragraph 158: When determining planning applications for renewable and low carbon development, local planning authorities should:

- a. not require applicants to demonstrate the overall need for renewable or low carbon energy, and recognise that even small-scale projects provide a valuable contribution to cutting greenhouse gas emissions; and approve the application if its impacts are (or can be made) acceptable. Once suitable areas for renewable and low carbon energy have been identified in plans, local planning authorities should expect subsequent applications for commercial scale projects outside these areas to demonstrate that the proposed location meets the criteria used in identifying suitable areas.

## 4.2 LOCAL POLICY

### **Cornwall Council**

#### **Local Plan**

#### **Adopted November 2016**

##### **Policy 1: Presumption in favour of sustainable development**

When considering development proposals the Council will take a positive approach that reflects the presumption in favour of sustainable development contained in the National Planning Policy Framework and set out by the policies of this Local Plan.

We will work with applicants, infrastructure providers and the local community to find solutions which mean that proposals will be approved wherever possible, and to secure development that improves the economic, social and environmental conditions in the area.

Planning applications that accord with the policies in this Local Plan and supporting Development Plan (including, where relevant, with policies in Neighbourhood Plans) will be regarded as sustainable development and be approved, unless material considerations indicate otherwise.

When considering whether a development proposal is sustainable or not, account will be taken of its location, layout, design and use against the three pillars of economic development, social development and environmental protection and improvement.

Where there are no policies relevant to the application or relevant policies are out of date at the time of making the decision the Council will grant permission unless material considerations indicate otherwise – taking into account whether:

- a) Any adverse impacts of granting permission would significantly and demonstrably outweigh the benefits, when assessed against the policies in the National Planning Policy Framework taken as a whole; or
- b) Specific policies in that Framework indicate that development should be restricted.



**Cornwall Council  
Climate Emergency Development Plan Document  
Adopted February 2023**

Cornwall Council declared a Climate Emergency in 2019 and an Ecological Emergency in 2022. As part of their plans for a Carbon Neutral Cornwall, they prepared the Climate Emergency Development Plan Document which includes policies to help address the climate and ecological emergencies.

The following policy is relevant to this energy strategy:

**Policy SEC1 – Sustainable Energy and Construction**

Development proposals will be required to demonstrate how they have implemented the principles and requirements set out by the policy below.

- 1) **The Energy Hierarchy**  
All proposals should embed the Energy Hierarchy within the design of buildings by prioritising fabric first, orientation and landscaping in order to minimise energy demand for heating, lighting and cooling. All proposals should consider opportunities to provide solar PV and energy storage.
- 2a) **New Development – Major Non-Residential**  
Development proposals for major (a floor space of over 1,000m<sup>2</sup>) non-residential development should demonstrate how they achieve BREEAM ‘Excellent’ or an equivalent or better methodology.
- 2b) **New Development – Residential**  
Residential development proposals will be required to achieve Net Zero Carbon and submit an ‘Energy Statement’ that demonstrates how the proposal will achieve:
  - Space heating demand less than 30kWh/m<sup>2</sup>/annum;
  - Total energy consumption less than 40kWh/m<sup>2</sup>/annum; and
  - On-site renewable generation to match the total energy consumption, with a preference for roof-mounted solar PV.

Where the use of onsite renewables to match total energy consumption is demonstrated to be not technically feasible (for example with apartments) or economically viable renewable energy generation should be maximised as much

as possible; and/or connection made to an existing or proposed low carbon district energy network; or where this is not possible the residual energy (the amount by which total energy demand exceeds the renewable energy generation) is to be offset by a contribution to Cornwall Council’s Offset Fund.

Where economic viability or technical constraints prevent policy compliance, proposals should first and foremost strive to meet the space heating and total energy consumption thresholds. Proposals must then benefit as much as possible from renewable energy generation and/or connection to an existing or proposed low carbon district energy network. As a last resort, any residual energy is to be offset by a contribution to Cornwall Council’s Offset Fund, as far as economic viability allows.

While this policy does not require the application of these standards to reserved matters applications that relate to outline planning permissions that predate the adoption of this climate Emergency DPD, developers are encouraged to apply these standards on a voluntary basis, where it is feasible to do so and not within breach of existing permissions.

- 3) **Existing Buildings**  
Significant weight will be given to the benefits of development resulting in considerable improvements to the energy efficiency and reduction in carbon emissions in existing buildings.

Proposals that help to increase resilience to climate change and secure a sustainable future for historic buildings and other designated and non-designated heritage assets will be supported and encouraged where they:

- a) Conserve (and where appropriate enhance/better reveal) the design, character, appearance and historical significance of the building; or
  - b) Facilitate their sensitive re-use where they have fallen into a state of disrepair or dereliction (subject to such a re-use being appropriate to the specific heritage asset).
- 4) **Domestic and Non-Residential Renewables**  
The Council will support domestic and non-residential renewables such as solar panels where they require planning permission.

Proposals should minimise visual impact wherever possible. Proposals affecting heritage assets, including their settings, shall seek to avoid and minimise negative impacts on their significance and conserve the character of historic townscapes, landscapes and seascapes.

5) Water

All dwellings (including conversions, reversions and change of use) should achieve an estimated water consumption of no more than 110 litres/person/day through the incorporation of water saving measures where feasible.

Development proposals for 50 or more dwellings and non-residential development with a floor space of 1,000 m<sup>2</sup> or more should incorporate water reuse and recycling and rainwater harvesting measures.

6) Materials and Waste

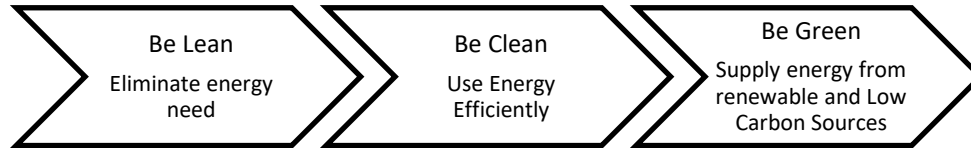
All development proposals should minimise use of materials creation of waste and promote opportunities for a circular economy through:

- a) Wherever possible reusing or adapting existing buildings as part of the development, whilst maintaining and enhancing local character and distinctiveness;
- b) Reuse and recycling of appropriate materials that arise through demolition and refurbishment, including the reuse of non-contaminated excavated soil and hardcore within the site;
- c) Prioritise the use of locally sourced and/or sustainable materials and construction techniques that have smaller ecological and carbon footprints;
- d) Using locally distinctive, resilient, low maintenance materials that are appropriate for Cornwall's damp maritime climate, for example locally won materials such as slate and granite (particularly for areas that will be harder to maintain once the building is occupied) as described in the Cornwall Design Guide;
- e) Considering the lifecycle of the development and surrounding area, actively prioritise design that delivers longevity and repairability including how developments can be adapted to meet changing needs and how materials can be recycled at the end of their lifetime;

- f) Providing adequate space to enable and encourage greater levels of recycling. Space requirements for residential developments should follow those outlined in the Cornwall Design Guide.

## 5. ENERGY STRATEGY APPROACH

The proposed energy strategy follows the established and widely accepted Energy Hierarchy of eliminate energy need (Be Lean), Use energy efficiently (Be Clean) and supply energy from renewable and low carbon sources (Be Green) to enable the maximum viable reductions in regulated and total CO<sub>2</sub> emissions over the baseline.



The proposed energy supply solutions aim to match energy profiles of the development ensuring effective use. The proposed solutions consider viability and flexibility of the scheme from both a technical and economic point of view by identifying best combination of energy efficiency measures as well as decentralised and renewable energy supply solutions.

Using these principles, Mr and Mrs Bawden will deliver the following objectives:

- Comply with the relevant regulatory requirements.
- To reduce energy and CO<sub>2</sub> demand through fabric and energy efficiency measures.
- To propose to reduce energy consumption and carbon dioxide emissions further through the use of on-site renewable or low and zero carbon technologies (LZC).

### 5.1 ENERGY AND CARBON ASSESSMENT METHODOLOGY

Elmhurst Energy software, which uses the Standard Assessment Procedure (SAP) 10.2 methodology to assess compliance with Part L1 2021, has been used to evaluate an initial CO<sub>2</sub> performance of representative residential dwellings. To assess energy performance of the entire residential development, an energy and carbon assessment model has been produced, which extrapolates the results of the SAP analysis using the floor area weighted average method detailed within Part L1 2021 to predict the energy consumption and CO<sub>2</sub> performance of the residential development.

Although the produced data detailed within this report provides estimations of possible energy and carbon performance of the development, it is not intended to be used as a detailed design tool.

## 6. BASELINE CO<sub>2</sub> EMISSIONS

In order to assess the energy demand and CO<sub>2</sub> performance of the proposed energy strategy, a baseline needs to be established. This section sets out the approach taken to calculating the baseline CO<sub>2</sub> emissions for the development.

The total baseline CO<sub>2</sub> emissions for the proposed development is defined as regulated CO<sub>2</sub> emissions, which is covered by Building Regulations Part L. Regulated CO<sub>2</sub> emissions are calculated from the CO<sub>2</sub> emissions associated with space heating, hot water and fixed electrical demands (for lights, fans and pumps).

Unregulated CO<sub>2</sub> emissions are those that are associated with appliances. Unregulated CO<sub>2</sub> emissions are not covered by Part L and are therefore not included as part of the assessment detailed within this energy strategy.

CO<sub>2</sub> Conversion Factors have been applied in accordance with the requirements of Building Regulations Part L 2021. These were detailed in the previous section of this report.

### 6.1 SAMPLE SAP UNITS

The baseline CO<sub>2</sub> emissions for the proposed development are based on the Part L1 2021 Target Emission Rate (TER) performance of representative dwellings. The baseline CO<sub>2</sub> performance has been determined by carrying out SAP 10.2 modelling to establish the TERs of sample dwellings. The TER sets a minimum allowable standard for the energy performance of a building and is defined by the annual CO<sub>2</sub> emissions of a notional building of the same type, size and shape to the proposed building. The specification of the notional building used to calculate the TER is defined within Building Regulations Part L1 2021. The representative dwellings presented in the following table were used to carry out the SAP assessment.

**Table 3: Representative Sample Dwellings**

| Type Reference | No. of Units |
|----------------|--------------|
| Plot 1         | 1            |
| Plot 2         | 1            |
| <b>Total</b>   | <b>2</b>     |

The TER of the representative dwellings can be found on the SAP output sheets in the appendices. The TER results of the SAP assessments from the representative dwellings have been extrapolated using a weighted average method to predict the baseline.

## 6.2 TOTAL BASELINE

The total baseline CO<sub>2</sub> emissions for the development are summarised below.

**Table 4: Total Baseline CO<sub>2</sub> emissions**

| Stage of Energy Hierarchy | Regulated CO <sub>2</sub> Emissions<br>(tonnes/year) |
|---------------------------|--|
| Part L1 2021 Baseline     | 9.12   |

## 7. PASSIVE DESIGN AND ENERGY EFFICIENT MEASURES (BE LEAN)



In accordance with the Energy Hierarchy, the energy demands of the development should be reduced as much as practically viable, prior to considering low carbon or renewable measures.

A range of measures to reduce CO<sub>2</sub> emissions and increase resilience to climate change are proposed in the building design including good building fabric standards as well as energy efficient M&E systems and lighting.

### 7.1 PASSIVE DESIGN

The development will incorporate a range of passive design measures and energy efficient building fabric that will reduce the demand for space heating, ventilation, and artificial lighting.

Passive design utilises daylight, solar energy and shading to illuminate, heat and shade where necessary and ventilate/cool the buildings, thus requiring less (mechanical) energy to achieve the performance standards for the health and wellbeing of the occupants.

Natural ventilation has been considered but is judged to be inappropriate due to the high energy efficiency requirements and the CO<sub>2</sub> reduction target. Therefore, mechanical ventilation with heat recovery (MVHR) has been specified as a more suitable approach to extract air from the dwellings, whilst maintaining thermal efficiency.

The ventilation strategy will be reviewed again and developed as the design progresses to ensure compliance with all the relevant regulations and standards. Should certain elevations be affected by noise issues restricting the opening of windows, enhanced mechanical ventilation will be introduced to reduce the risk of overheating. It is assumed, in this scenario, that all windows can still be opened (albeit intermittently) for purge ventilation.

The proposed glazed areas have been designed to maximise daylight and optimise solar gains. The glazing specification has been reviewed to ensure that they provide a balance between solar control and solar gain.

## 7.2 BUILDING FABRIC

To reduce demand for space heating, emphasis has been placed on providing a very high standard of fabric efficiency and reducing heat loss through the building envelope. Approved Document Part L1 2021 sets out the limiting fabric parameters for each of the building elements. Each stated value represents the area-weighted average U-value. The following table details the proposed U-values to be used in the described exposed element within the fabric of the development.

**Table 5: Proposed Fabric Specification**

| Element          | Part L1 2021 Minimum Fabric Requirements  | Proposed Specification  |
|------------------|---|---|
| Ground Floor     | 0.18 W/m <sup>2</sup> K                   | 0.12 W/m <sup>2</sup> K                                       |
| External Wall    | 0.26 W/m <sup>2</sup> K                   | 0.15 W/m <sup>2</sup> K                                       |
| Party Wall       | 0.20 W/m <sup>2</sup> K                   | 0.00 W/m <sup>2</sup> K                                       |
| Roof- Cold       | 0.16 W/m <sup>2</sup> K                   | 0.09 W/m <sup>2</sup> K                                       |
| Roof- Warm       | 0.16 W/m <sup>2</sup> K                   | 0.13 W/m <sup>2</sup> K                                       |
| Windows          | 1.60 W/m <sup>2</sup> K                   | U = 0.80 W/m <sup>2</sup> K<br>G = 0.58<br>Frame Factor = 0.7 |
| Roof Lights      | 1.60 W/m <sup>2</sup> K                   | U = 1.1 W/m <sup>2</sup> K                                    |
| Doors            | 1.60 W/m <sup>2</sup> K                   | 1.00 W/m <sup>2</sup> K                                       |
| Air Permeability | 8.0m <sup>3</sup> /h/m <sup>2</sup> @50Pa | 1.50m <sup>3</sup> /h/m <sup>2</sup> @50Pa                    |

Approved construction details for all wall junctions will be specified to minimise the effects of non-repeating thermal bridging and reduce heat loss further. By specifying and ensuring that approved construction details are designed into the build, CO<sub>2</sub> emissions can be greatly reduced. In addition, it is proposed that all openings will have Hi-Therm lintels installed to maximise thermal efficiency.

### 7.3 ENERGY EFFICIENT SYSTEMS

Energy efficiency can be significantly reduced by using energy efficient M&E systems. The recommended indicative energy efficiency measures for the proposed development are provided below and have been included within the energy and carbon modelling.

#### 7.4.1. HEATING AND HOT WATER

The space heating requirement of the proposed development will be significantly reduced by the proposed fabric, air tightness and ventilation measures.

It is proposed that the dwellings will have their heating and hot water supplied through highly efficient individual air source heat pumps. However, as this technology is considered a low and zero carbon technology, it can only be considered at the 'Be Green' stage of this energy hierarchy. Therefore, for the purpose of reporting the 'Be Lean' figures, gas combination boilers have been assumed at the 'Be Lean' stage. This is consistent with the heating that is assumed in the notional building which is used to calculate the TER.

#### 7.4.2. VENTILATION

To further minimise heat loss through the building envelope, air leakage will be made a priority. The airtightness of the dwellings will be set to a level of  $1.50\text{m}^3/\text{h}/\text{m}^2$  and will utilise mechanical ventilation with heat recovery (MVHR) to ensure the airtightness of the dwellings can be kept low, without compromising on the necessity for good ventilation. A more detailed ventilation strategy will be developed during detailed design with the aim to specify the most appropriate ventilation systems and achieve a pleasant indoor environment.

#### 7.4.3. COOLING

At this stage, it is considered that cooling requirements during the hot summer months will be met via openable windows/ doors and mechanical ventilation with heat recovery enhanced ventilation rates.

#### 7.4.4. LIGHTING

The proposed windows aim to maximise daylight to minimise the need for artificial lighting. The electricity consumption associated with lighting will be further reduced by effectively controlling the lighting systems by:

- Using energy efficient lamps and luminaires. Low energy lamps and LED's are proposed throughout.
- Having appropriately commissioned lighting systems.

#### 7.4.5. ENERGY METERING AND MONITORING

Electric sub-metering will be installed in line with CIBSE TM39 to monitor and target energy use within the development. Each individual apartment will have their own meter and it is likely that energy suppliers may insist on smart metering throughout.

## 7.4 RESIDENTIAL FABRIC ENERGY EFFICIENCY (FEE)

The Target Fabric Energy Efficiency rate is the minimum energy performance requirement, as stipulated by Building Regulations Part L1 2021, for all new residential dwellings. It is expressed as the amount of energy demand in units of kilowatt-hours per square metre of floor area per year. This performance metric is influenced by the fabric only, which is why it can be reported at this stage of the energy hierarchy.

The energy strategy has reduced energy demand through fabric and energy efficiency measures. The demand has been shown to have been reduced by an average of 17%, as detailed in the table below.

**Table 6: Residential FEE Performance**

| Element           | Target Fabric Energy Efficiency (TFEE) kWh/m <sup>2</sup> /year | Dwelling Fabric Energy Efficiency (DFEE) kWh/m <sup>2</sup> /year | Improvement (%) |
|-------------------|---|---|-----------------|
| Residential Total | 43.18   | 35.83   | 17%             |

## 7.5 TOTAL CO<sub>2</sub> SAVINGS: BE LEAN

The total 'Be Lean' CO<sub>2</sub> emissions for the development are summarised below and compared against the baseline figure.

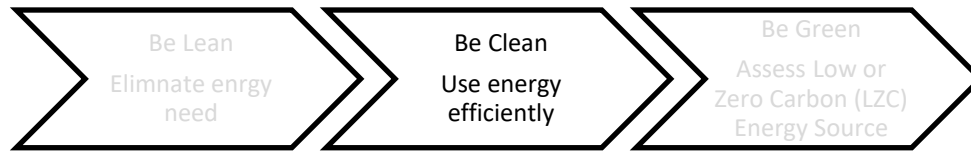
**Table 7: Total 'Be Lean' CO<sub>2</sub> Emissions**

| Stage of Energy Hierarchy | Regulated CO <sub>2</sub> Emissions (tonnes/year) |
|---------------------------|---|
| Total Baseline            | 2.705   |
| Total After 'Be Lean'     | 1.748   |
| <b>Total Saving</b>       | <b>0.96</b>                                       |
| <b>Total Improvement</b>  | <b>35%</b>  |

It should be noted that the above 'Be Lean' figures have been adjusted to account for the PV that is included within the notional building (Part L 2021) when calculating the TER for the baseline. PV is considered a renewable energy source, so it would not be a fair assessment of the actual 'Be Lean' savings if these were to be compared against a baseline (TER) which has the benefit of PV. A carbon reporting spreadsheet has been used to calculate the estimated carbon savings of the PV within the baseline (TER). The same amount of carbon savings has then been deducted from the 'Be Lean' figure reported above. This then enables a like for like comparison of the baseline and 'Be Lean' figures.



## 8. SUPPLY ENERGY EFFICIENTLY (BE CLEAN)



### Combined Heat and Power (CHP)

Decentralised energy refers to energy that is generated off the main grid. This may include micro-renewables, heating and cooling. It can also refer to energy from waste plants, combined heat and power, district heating and cooling, as well as geothermal, biomass or solar energy. Decentralised Energy schemes can serve a single building or a whole community, even being built out across entire cities.

The heat source for the communal heating system should be selected in accordance with the following heating hierarchy:

1. Connect to local or existing planned heat networks
  - a. Use zero-emission or local secondary heat sources (in conjunction with heat pump, if required)
  - b. Use low-emission combined heat and power (CHP) (only where there is a case for CHP to enable the delivery of an area-wide heat network)
  - c. Use ultra-low NOx gas boilers
2. CHP and ultra-low NOx gas boiler communal or district heating systems should be designed to ensure that they meet the relevant planning policy requirements.
3. Where a heat network is planned but not yet in existence the development should be designed for connection at a later date.

There are many benefits of decentralised heat generation and Combined Heat and Power (CHP) in terms of cost and CO<sub>2</sub> emissions savings. However, technology such as this is more significant for larger developments, ideally complimented with some non-residential use of heat and electricity. The proposed development size of 2 dwellings is at the lower end of what the industry tends to view as viable for such systems. The development is for residential only and this will result in 'peaky' thermal demands with little anchor load to

enable efficient operation of gas fired CHP. This option also risks the potential to increase costs to residents.

The site is neither sufficiently dense nor large enough to warrant investment from 3rd party managing agents or Energy Supply Companies (ESCOs). The proposed development would need to be run by an independent agent/company and there would be very little if any interest among existing ESCOs in servicing such a small-scale system. Even if it was possible, the cost of managing fuel procurement, customer billing, operation and maintenance would lead to disproportionately and unnecessary high service charges to residents compared to the provision of heat from individual heating sources.

Based on the anticipated timescale of the proposed development and the predicted trajectory of the national electricity grid decarbonisation, the development of a district heat network powered by fossil fuels is also not considered to be the most carbon efficient approach.

The incorporation of a gas fired combined heat and power (CHP) network will lock the development into relatively carbon intensive gas-fired heating and hot water technology, and will not facilitate the transition to less carbon intensive solutions.

## 9. RENEWABLES OR LZC TECHNOLOGY (BE GREEN)



The following low and zero carbon technologies have been considered for this scheme:

- Air Source Heat Pump (ASHP)
- Domestic Hot Water Heat Pumps
- Photovoltaic Panels (PV)
- Ground Source Heat Pump (GSHP)
- Wind Turbines
- Biomass Boiler
- Solar Thermal

The assessment has shown that individual Air Source Heat Pumps and PV are considered to be the most suitable renewable/low carbon energy solution for this development.

All other renewable energy technology options are summarised in the appendices and have been deemed as not appropriate for this development.

### 9.1 AIR SOURCE HEAT PUMPS (ASHP)

Air at any temperature above absolute zero contains some energy. An air source heat pump transfers some of this energy as heat from one place to another, for example, between the outside and inside of a building. This can provide space heating and hot water. A system can be designed to transfer heat in either direction, to heat or cool the interior of the building in winter and summer respectively. For simplicity, the description below focuses on use for interior heating.

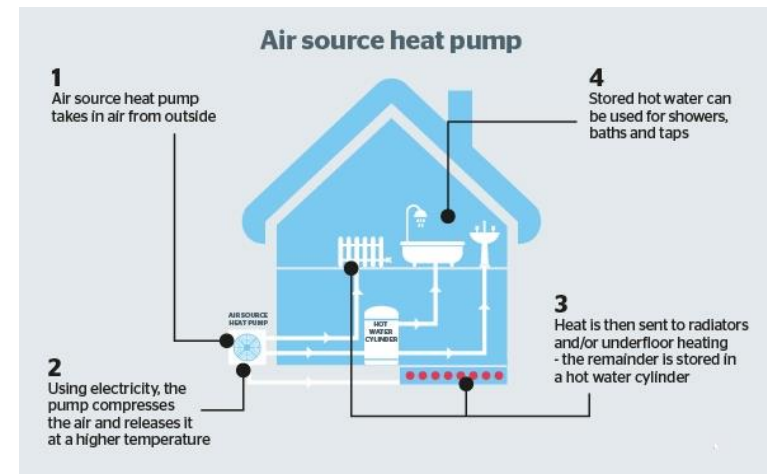
The technology is similar to a refrigerator/freezer or air conditioning unit. The different effect is due to the physical location of the different system components. Just as the pipes on the back of a refrigerator become warm as the interior cools, so an ASHP warms the inside of a building whilst cooling the outside air.

The main components of an ASHP are:

- An outdoor heat exchanger coil, which extracts heat from ambient air.
- An indoor heat exchanger coil, which transfers the heat into hot air ducts, an indoor heating system such as water-filled radiators or underfloor circuits and a domestic hot water tank.

The figure below demonstrates the typical operation of an ASHP system used to supply space heating and hot water to a property.

**Figure 2: Example diagram of ASHP System**



Some of the key advantages of ASHPs are listed below:

- ASHPs save carbon emissions. Unlike burning oil, gas, LPG or biomass, a heat pump produces no carbon emissions on-site (and no carbon emissions at all, if a renewable energy source is used to power them).
- They save space. There are no fuel storage requirements.
- They require less maintenance than combustion based heating systems.
- Heat pumps can provide cooling in summer, as well as heating in winter.
- There is no combustion involved and no direct emission of harmful gases.

The use of individual Air Source Heat Pumps (ASHP) is proposed for this development to efficiently supply the dwellings with space heating and hot water. The ASHP are to be discreetly located within the boundary of each plot.

ASHPs will require electricity to operate, however this electricity can be supplied by renewable sources. This will future proof the home against the decarbonisation of the electricity grid.

A datasheet for the ASHP specified within the SAP calculations for the purpose of this report, has been included within the appendices.

The full design of this system will be further developed during the detailed design stage.

## 9.2 BUILDING SERVICES ENERGY EFFICIENCY MEASURES

The building services and systems to be employed within the dwellings are summarised in the following table.

**Table 8: Summary of Building Services**

| Building Service Element              | Specification  |
|---------------------------------------|--|
| <b>Heating:</b>                       | Air Source Heat Pumps<br>Vaillant aroTHERM plus 7kW                                |
| <b>Heating Emitter:</b>               | Radiators and underfloor heating   |
| <b>Secondary Heating:</b>             | None   |
| <b>Heating Hot Water Controls:</b>    | Time and Temperature Zone Control<br>Delayed Start Stat<br>No Weather Compensation |
| <b>Flue Gas Heat Recovery:</b>        | None   |
| <b>Cylinder:</b><br><b>Heat Loss:</b> | 2500 litre cylinder (to be confirmed)<br>1.6 kWh/24 Hr                             |
| <b>Ventilation:</b>                   | System 4 fans<br>MVHR – Zehnder ComfoAir Q350 GB ST or similar                     |
| <b>Waste Water Heat Recovery:</b>     | None   |
| <b>Showers:</b>                       | Flow rate = 8 litres per minute  |

### 9.3 PHOTOVOLTAIC PANELS (PV)

Solar PV technology offers advantages over other low carbon and renewable energy technologies for the following reasons:

#### Density/scale

Solar technologies are modular and can be sized to available space constraints and would easily be integrated into the roofscape of the proposed development.

Solar PV technologies typically require 2-3 times more space to generate the equivalent energy or abate similar emissions as solar thermal panels, but they can be sized to the maximum available roof space.

#### Technology Integration

Solar technologies can be easily integrated into the built environment using available roof space. Since they are modular and easily fixed to buildings, they can access solar irradiation in almost any location. The technologies can be integrated on almost any roof structure or vertical façade without compromising structural or aesthetic requirements.

Solar PV systems are generally connected to the dwelling or block via an inverter and any excess generation not utilised on-site is exported seamlessly to the local grid.

#### Cost-effectiveness

Solar PV costs have reduced dramatically in the last 2-3 years in the UK, due to increasing demand for the technology driven by sustainability requirements and the Government's stimulus package known as the Feed-In Tariffs (FITs) scheme which rewards renewable electricity generation with premium tariffs.

#### CO<sub>2</sub> Abatement Capacity

Solar PV generates electricity and abates ~2.5 - 3 times more CO<sub>2</sub> than an alternative renewable energy technology that displaces use of gas (e.g. solar hot water technology and/or biomass boilers). Solar PV is well proven with good historical data showing that its performance credentials generally match or exceed manufacturers' claims/modelled generation profiles.

In addition to achieving compliance with Building Regulations Part L1 2021, Cornwall Council's Policy SEC1 Part 2b requires that all new dwellings must have on-site renewable generation to match the total energy consumption of the dwelling. This has been calculated using Cornwall Council's Energy Summary Tool (SAP V2.0) and has ultimately influenced the total quantity of PV that is required to each dwelling.

The PV schedule below details the quantity of PV panels that will be required to each dwelling type. The PV panels are proposed to be sited within the rear garden as per figure over leaf.

**Table 9: Proposed PV Schedule**

| Type          | Number of Units | Total Quantity of PV (kWp) |
|---------------|-----------------|----------------------------|
| Plot 1        | 1               | 3.2                        |
| Plot 2        | 1               | 4.0                        |
| <b>TOTAL:</b> | <b>2</b>        | <b>7.2</b>                 |

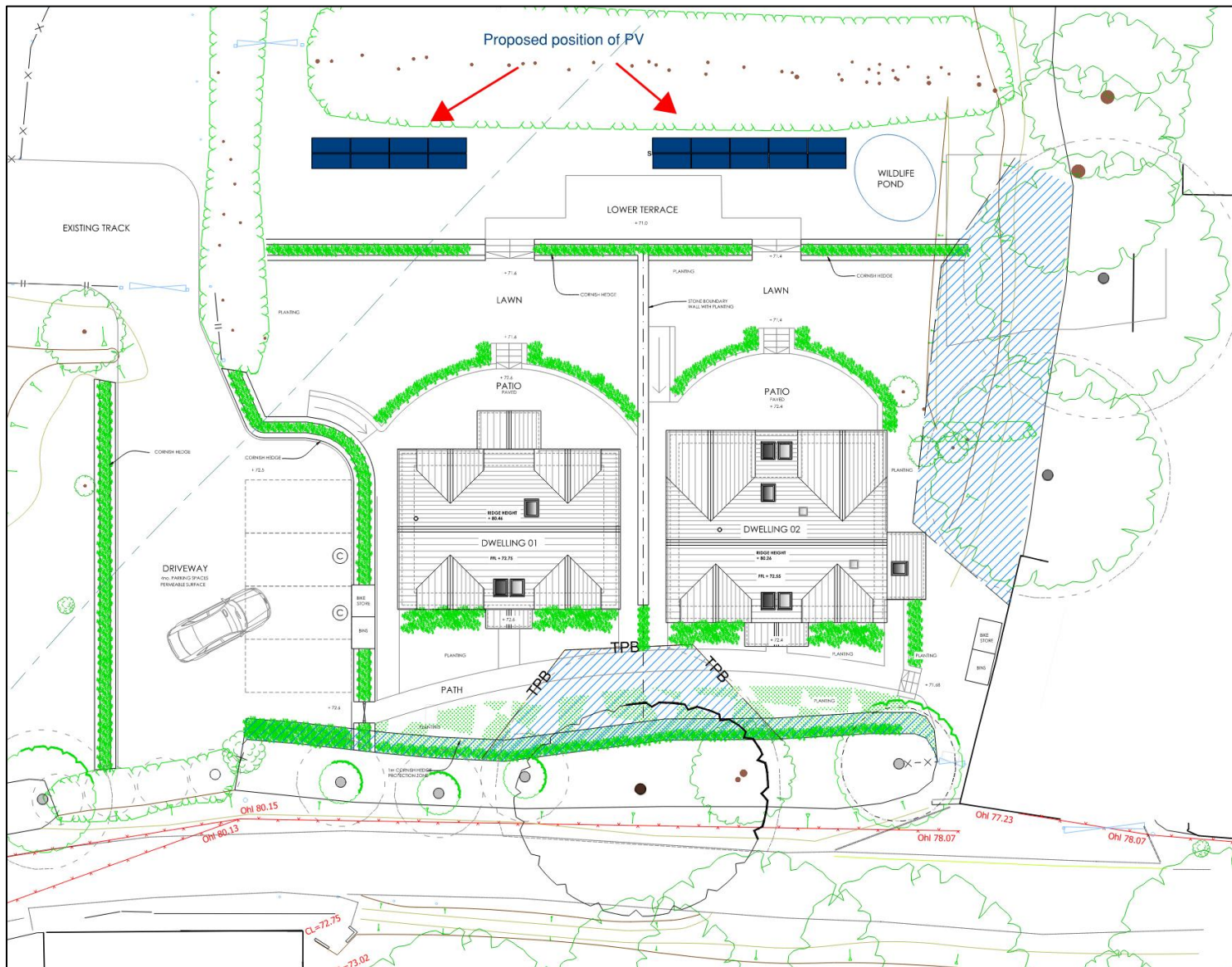
Solar radiation falling upon a roof varies depending on its orientation. Therefore, it should be ensured that the panels are orientated to face south so that exposure to solar radiation is maximised for each PV panel. In an effort to further increase the efficiency, each panel should be fixed to the roof via a ballast at an inclination of 30°.

The predicted CO<sub>2</sub> savings through the introduction of the PV panels has been summarised as detailed in the table.

**Table 10: Summary of PV including CO<sub>2</sub> abatement**

| Item                            | Quantity | Metric                  |
|---------------------------------|----------|-------------------------|
| Assumed Power of PV Cell        | 400      | Wp                      |
| Estimated Total No. of PV Cells | 18       | No                      |
| Total kWp                       | 7.2      | kWp                     |
| Total CO <sub>2</sub> saving    | 1,800    | kgCO <sub>2</sub> /year |

**Figure 3: Proposed PV location**



**Total CO<sub>2</sub> Savings: Be Green**

The total 'Be Green' CO<sub>2</sub> emissions for the development are summarised below and compared against the previous stages of the energy hierarchy.

**Table 11: Total 'Be Green' CO<sub>2</sub> Emissions**

| Stage of Energy Hierarchy | Regulated CO <sub>2</sub> Emissions (tonnes/year) |
|---------------------------|---|
| Total Baseline            | 2.705   |
| Total After 'Be Lean'     | 1.748   |
| Total After 'Be Green'    | -0.1  |
| <b>Total Saving</b>       | <b>2.81</b>                                       |
| <b>Total Improvement</b>  | <b>104%</b>                                       |

As detailed above, the dwellings will achieve an average CO<sub>2</sub> reduction of 97% when compared to a Part L1 2021 baseline. This is an exceptional level of CO<sub>2</sub> reduction and clearly extends far beyond what is required from a Building Regulations perspective. Furthermore, this will ensure that the dwellings will achieve an 'A' rated Energy Performance Certificate (EPC).

## 10. COMPLIANCE WITH POLICY SEC1 PART 2B

As detailed previously, Cornwall Council introduced the Climate Emergency Development Plan Document in February 2023. Policy SEC1 part 2b of this document holds particular relevance to this energy strategy as it details the following requirements for new residential development proposals:

- Space heating demand less than 30kWh/m<sup>2</sup>/annum;
- Total energy consumption less than 40kWh/m<sup>2</sup>/annum; and
- On-site renewable generation to match the total energy consumption, with a preference for roof mounted solar PV.

The energy strategy detailed herein has been formed taking into account all three of the above requirements. To support applicants demonstrate compliance with the above requirements, Cornwall Council has produced a Energy Summary Tool (SAP V2.0) which can be downloaded by their website. Upon completion of the sample SAP calculations, the Energy Summary Tool (SAP 2.0) was completed and the resulting worksheets can be found in the appendices of this report. A summary of the results are detailed in the table below:

**Table 12: Results Summary of Policy SEC1 part 2b requirements**

| Policy SEC1 Part 2b | Space Heat Demand<br>kWh/m <sup>2</sup> /annum | Total Energy Consumption<br>kWh/m <sup>2</sup> /annum | On-site Renewable Generation<br>% of Total Energy |
|---------------------|--|---|---|
| Required Values:    | < 30   | < 40  | 100%  |
| Plot 1              | 27.8   | 29.9  | 102%  |
| Plot 2              | 29.6   | 26.6  | 110%  |

As can be seen in the above table, both plots are demonstrating compliance with all three of the main performance criteria required by Cornwall Council within their Policy SEC1 part 2b.



## 11. WATER SAVING MEASURES

Household water reduction measures will include the following where applicable:

- Water efficient taps.
- Water efficient cisterns.
- Low output showers.
- Flow restrictors to manage water pressures to achieve optimum levels.
- Water meters to all premises with guidance on water consumption and savings.

The following specification or similar will be adopted on the development to ensure that the water efficiency of the dwelling will achieve a maximum of 110 litres/person/day in line with the requirements of Policy SEC1 part 5 of Cornwall Council's Climate Emergency Development Plan Document.

**Table 13: Specification of flow rates and volumes for water using appliances**

| Water using Appliance | Specification  |
|-----------------------|--|
| WC Cisterns           | Dual Flush to be limited to maximum of 6/3                 |
| Baths                 | Capacity no greater than 190 litres                        |
| Basin taps            | Flow rates to be no greater than 3 litres/minute           |
| Kitchen taps          | Flow rates to be no greater than 6 litres/minute           |
| Shower                | Flow rates to be no greater than 8 litres/minute           |
| Water softener        | Not to be installed  |
| Washing Machine       | Water usage to be limited to 8.17 Litres per KG            |
| Dishwasher            | Water Usage to be limited to 1.25 litres per place setting |

**Table 14: Water Calculations**

| Water Calculations                          |                |                        |            |                        |                        |
|---|----------------|------------------------|------------|------------------------|------------------------|
| Installation Type                           | Unit           | Capacity/<br>Flow Rate | Use Factor | Fixed use<br>(l/p/day) | Total Use<br>(l/p/day) |
| WC Single Flush                             | Volume (l)     | 0.00                   | 4.42       | 0.00                   | 0.00                   |
| WC Dual Flush                               | Full Flush (l) | 6.00                   | 1.46       | 0.00                   | 8.76                   |
|   | Pt Flush (l)   | 3.00                   | 2.96       | 0.00                   | 8.88                   |
| WC's (Multiple)                             | Volume (l)     | 0.00                   | 4.42       | 0.00                   | 0.00                   |
| Taps Exc. Kitchen                           | Flow Rate      | 3.00                   | 1.58       | 1.58                   | 6.32                   |
| Bath (shower present)                       | (l/m)          | 190.00                 | 0.11       | 0.00                   | 20.90                  |
| Shower (bath present)                       | (l/m)          | 8.00                   | 4.37       | 0.00                   | 34.96                  |
| Bath Only                                   | (l)            | 0.00                   | 0.50       | 0.00                   | 0.00                   |
| Shower Only                                 | (l/m)          | 0.00                   | 5.60       | 0.00                   | 0.00                   |
| Kitchen Taps                                | (l/m)          | 6.00                   | 0.44       | 10.36                  | 13.00                  |
| Washing Machines                            | (l/kg/dry)     | 8.17                   | 2.10       | 0.00                   | 17.16                  |
| Dishwashers                                 | (l/place)      | 1.25                   | 3.60       | 0.00                   | 4.50                   |
| Waste Disposal                              | (l/s)          | 0.00                   | 3.08       | 0.00                   | 0.00                   |
| Water Softener                              | (l/s)          | 0.00                   | 1.00       | 0.00                   | 0.00                   |
| <b>Total Calculated Water Use (l/p/day)</b> |                |                        |            |                        | <b>114.50</b>          |
| Grey/Rain Water Reused (l)                  |                |                        |            |                        | 0.00                   |
| Normalisation Factor                        | (Factor)       |                        |            |                        | 0.91                   |
| <b>Total Internal Consumption (l/p/day)</b> |                |                        |            |                        | <b>104.20</b>          |
| External Water Use Allowance (l)            |                |                        |            |                        | 5.00                   |
| <b>Total Consumption Part G (l/p/day)</b>   |                |                        |            |                        | <b>109.20</b>          |



## 12. CONCLUSIONS

The energy strategy has followed the widely accepted Energy Hierarchy of Be Lean, Be Clean and Be Green. The energy strategy proposed for the development can be summarised as below.

**Table 15: Proposed Energy Strategy**

| Element     | Measure  |
|-------------|--|
| Passive     | Optimised design to enable controlled solar gain and improved direct and indirect natural lighting |
| Fabric      | Building fabric U values have been enhanced over and above those detailed with Part L1 2021        |
| Heating     | Individual ASHP to supply heat to the dwellings  |
| Hot Water   | Individual ASHP to supply hot water to the dwellings   |
| Ventilation | Mechanical ventilation with heat recovery (MHVR)<br>Low design air permeability (DAP)              |
| Lighting    | Energy efficient LED Lighting where applicable   |
| PV          | 7.2 kWp of PV panels   |

### 12.1 TOTAL CO<sub>2</sub> SAVINGS

A summary of the overall reduction in regulated CO<sub>2</sub> emissions after all stages of the energy hierarchy, is detailed in the table below.

**Table 16: Energy Strategy Carbon Emissions Summary**

| Stage of Energy Hierarchy | Regulated CO <sub>2</sub> Emissions (tonnes/year) |
|---------------------------|---|
| Total Baseline            | 2.705   |
| Total After 'Be Lean'     | 1.748   |
| Total After 'Be Green'    | -0.1  |
| <b>Total Saving</b>       | <b>2.81</b>                                       |
| <b>Total Improvement</b>  | <b>104%</b>                                       |

The proposed inclusion of individual ASHPs and PV panels to the development, along with the energy efficiency improvements, will save an estimated 2.81 tonnes of regulated CO<sub>2</sub> per year. This represents an 104% saving over the current Building Regulations Part L 2021 baseline.

In addition to the above, the energy strategy has fully followed and adhered to the three main performance criteria stipulated by Cornwall Council within their Policy SEC1 part 2b. Their Energy Summary Tool (SAP V2.0) has been completed, which demonstrates compliance with the energy performance requirements. The worksheets of this can be found within the appendices.

## 13. APPENDICES

The following pages detail:

- Appendix A: Alternative Renewable Energy Options
- Appendix B: ASHP Details
- Appendix C: Cornwall Council's Energy Summary Tool (SAP V2.0) Worksheets
- Appendix D: SAP Output Sheets

## 13.1 APPENDIX A: ALTERNATIVE RENEWABLE ENERGY OPTIONS

The following alternative options to supply low carbon and renewable energy generation have been explored and discounted based on the following reasons:

### Wind Turbines

Wind turbines come in a variety of sizes and shapes. Turbines of 1 kW can be installed to single house and large-scale turbines of 1-2 MW can be installed on a development to generate electricity to multiple dwellings and other buildings. In both instances the electricity generated can be used on site or exported to the grid. Vertical- or horizontal-axis turbines are available.

A roof-mounted 1 kW micro wind system costs up to £3,000. A 2.5 kW pole-mounted system costs between £9,900 and £19,000. A 6 kW pole-mounted system costs between £21,000 and £30,000 (taken from the Energy Saving Trust, TBC by supplier)

- Local average wind speed is a determining factor. A minimum average wind speed of 6 m/s is required.
- Noise considerations can be an issue dependent on density and build-up of the surrounding area.
- Buildings in the immediate area can disrupt wind speed and reduce performance of the system.
- Planning permission will be required along with suitable space to site the turbine, whether ground installed or roof mounted.

Wind turbines have been discounted due to concerns over reliable wind resources. The use of wind turbines is likely to present aesthetic as well as nuisance issues.

### Biomass Boilers

Providing a heating system fuelled by plant-based materials such as wood, crops or food waste. Biomass boilers generate heat for space heating and domestic hot water through the combustion of biofuels, such as woodchip, wood pellets or potentially biofuel or bio diesel. Biomass is considered to be virtually zero carbon. They can be used on an individual scale or for multiple dwellings as part of a district-heating network. A back-up heat source should be provided as consistent delivery of fuel is necessary for continued operation.

Biomass is considered a technically-viable option for this development scheme as there are no apparent physical constraints on site in terms of installing biomass boilers or storing a sufficient supply.

- There are, however, concerns regarding a sustainable supply of biomass to the site.
- The capital installation cost would also be high which leads us to the conclusion that biomass would not be a commercially-viable option for this development scheme.

### Ground Source Heat Pumps (GSHP)

Ground Source Heat Pumps (GSHPs) operate on the same principle as an Air Source Heat Pump (ASHP) in that they extract heat from a source (in this instance the ground) and compress this energy to increase temperature for space heating and hot water. Pipework is installed into the ground, either through coils or in bore holes and piles, circulating a mix of water and antifreeze to extract energy from the ground, where the year-round temperature is relatively consistent (approx. 10°C at 4 metres depth). This leads to a reliable source of heat for the building.

Again, an electrically powered pump circulates the liquid and powers the compressor, however annual efficiencies for GSHPs tend to be higher than those of ASHPs.

Discounted on the grounds of costs and available space. Incompatible with individual gas boilers and blocks of apartments.

**Solar Thermal**

Solar Thermal generates domestic hot water from the sun's radiation. Glycol circulates within either flat plate or evacuated tube panels, absorbing heat from the sun, and transferring this energy to a water cylinder. A well designed solar thermal system will account for 50-60% of a dwelling's annual hot water demand. Sizing the system to meet a higher demand will lead to excess heat generation in the summer months and overheating of the system.

Unsuitable for blocks of flats and low carbon reduction efficiency compared to photovoltaic systems. Solar hot water systems for flatted blocks are only suitable where a central boiler plant room is provided to accommodate a central thermal store.

## 13.2 APPENDIX B: ASHP DETAILS

### AIR SOURCE HEAT PUMP

# aroTHERM plus

A low carbon heating and hot water solution

- ✓ Future-proof thanks to the most cutting-edge heat pump technology with natural refrigerant, reducing your carbon footprint
- ✓ High energy efficiency class
- ✓ Ideal for retro-fit and new buildings
- ✓ Compact and super quiet
- ✓ Outstanding quality and durability
- ✓ Eligible for the Boiler Upgrade Scheme Grant in England and Wales



### 13.3 APPENDIX C: CORNWALL COUNCIL'S ENERGY SUMMARY TOOL (SAP V2.0) WORKSHEETS



SAP Conversion Tool V2.0  
Climate Zone: 4 South West England

| ↓ INSERT INFORMATION HERE ↓ |                  |                      |                   | ↓ INSERT INFORMATION HERE ↓   |           |          |                   |                |        |                               |                        |                              |                           |                    |                 |                     |                       |               |     |     | ↓ INSERT INFORMATION HERE ↓ |     |     |     |     |     |                           |     |     |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |
|-----------------------------|------------------|----------------------|-------------------|-------------------------------|-----------|----------|-------------------|----------------|--------|-------------------------------|------------------------|------------------------------|---------------------------|--------------------|-----------------|---------------------|-----------------------|---------------|-----|-----|-----------------------------|-----|-----|-----|-----|-----|---------------------------|-----|-----|-----------------------------|--------------------------|-------------------------------|--------------------------|------------------------|---------------------------|--------------------------------|--|--------------------------------------|-------------------------------------|---|
| Results                     |                  |                      |                   | Inputs - general              |           |          |                   |                |        | Inputs - Space Heating Demand |                        |                              |                           |                    |                 |                     |                       |               |     |     |                             |     |     |     |     |     | Inputs - Total Energy Use |     |     |                             |                          |                               |                          |                        |                           |                                | Inputs - Renewables                    |                                      |                                     |   |
| Space heat demand           | Total energy use | Renewable generation | Renewable deficit | Quantity                      | Plot Name | Bedrooms | Number of storeys | SAP Floor Area | Volume | Site Exposure                 | Air permeability @50Pa | Total area external elements | Total area party elements | Ventilation system | Heat recovery % | Thermal mass kJ/m2K | Fabric heat loss W/m2 | Solar gains W |     |     |                             |     |     |     |     |     |                           |     |     | Space heat source (Primary) | Heating efficiency [206] | Space heat source (Secondary) | Heating efficiency [207] | Fraction of heat [201] | Domestic hot water source | Water heating efficiency [214] | Hot water storage losses kWh/year [46] | Pumps and fans energy kWh/year [231] | Lighting Efficacy lumens/Watt [233] | Renewable Generation (negative number) kWh/year [235] |
| kWh/m2/yr                   | kWh/m2/yr        | % total energy       | kWh/year          |                               |           |          |                   | m2             | m3     |                               | m3/m2hr                | m2                           | m2                        |                    | %               | kJ/m2K              | W/m2                  | Jan           | Feb | Mar | Apr                         | May | Jun | Jul | Aug | Sep | Oct                       | Nov | Dec |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |
| <30                         | <40              | 100%                 | 0                 |                               |           |          |                   | [4]            | [5]    |                               | [17]                   | [31]                         | [32]+[33]+[34]            |                    | [35]            | [37]                |                       |               |     |     |                             |     |     |     |     |     |                           |     |     |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |
| 30.0                        | 33.4             | 107%                 | 0                 |                               |           |          |                   |                |        |                               |                        |                              |                           |                    |                 |                     |                       |               |     |     |                             |     |     |     |     |     |                           |     |     |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |
| 27.8                        | 29.9             | 107%                 | 0                 |                               |           |          |                   |                |        |                               |                        |                              |                           |                    |                 |                     |                       |               |     |     |                             |     |     |     |     |     |                           |     |     |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |
| 25.6                        | 26.6             | 110%                 | 0                 |                               |           |          |                   |                |        |                               |                        |                              |                           |                    |                 |                     |                       |               |     |     |                             |     |     |     |     |     |                           |     |     |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |
| Total                       |                  |                      |                   |                               |           |          |                   |                |        |                               |                        |                              |                           |                    |                 |                     |                       |               |     |     |                             |     |     |     |     |     |                           |     |     |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |
|                             |                  |                      |                   | EXAMPLE - Semi Detached House |           |          |                   |                |        |                               |                        |                              |                           |                    |                 |                     |                       |               |     |     |                             |     |     |     |     |     |                           |     |     |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |
|                             |                  |                      |                   | 1 Plot 1                      |           |          |                   |                |        |                               |                        |                              |                           |                    |                 |                     |                       |               |     |     |                             |     |     |     |     |     |                           |     |     |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |
|                             |                  |                      |                   | 1 Plot 2                      |           |          |                   |                |        |                               |                        |                              |                           |                    |                 |                     |                       |               |     |     |                             |     |     |     |     |     |                           |     |     |                             |                          |                               |                          |                        |                           |                                |  |                                      |                                     |   |

## 13.4 APPENDIX D: SAP OUTPUT SHEETS



# Summary for Input Data



|                      |   |                |            |
|----------------------|---|----------------|------------|
| Property Reference   | Plot 1  | Issued on Date | 21/12/2023 |
| Assessment Reference | 00001   | Prop Type Ref  | Plot 1     |
| Property             | Plot 1, Ryeland, Trevanna Cross, St Mawgan, Cornwall, TR8 4HB |                |            |

|                                    |          |               |       |      |        |
|------------------------------------|----------|---------------|-------|------|--------|
| SAP Rating                         | 98 A     | DER           | -0.39 | TER  | 11.24  |
| Environmental                      | 100 A    | % DER < TER   |       |      | 103.47 |
| CO <sub>2</sub> Emissions (t/year) | -0.13    | DFEE          | 33.21 | TFEE | 41.23  |
| Compliance Check                   | See BREL | % DFEE < TFEE |       |      | 19.46  |
| % DPER < TPER                      | 87.38    | DPER          | 7.41  | TPER | 58.75  |

|                  |                         |             |           |
|------------------|-------------------------|-------------|-----------|
| Assessor Details | Mr. Matthew Fitzpatrick | Assessor ID | 7601-0001 |
| Client           |                         |             |           |

## SUMMARY FOR INPUT DATA FOR: New Build (As Designed)

|                                |                     |                     |
|--------------------------------|---------------------|---------------------|
| Orientation                    | North               |                     |
| Property Tenure                | 1                   |                     |
| Transaction Type               | 6                   |                     |
| Terrain Type                   | Rural               |                     |
| 1.0 Property Type              | House, Detached     |                     |
| Which Floor                    | 0                   |                     |
| 2.0 Number of Storeys          | 2                   |                     |
| 3.0 Date Built                 | 2023                |                     |
| 3.0 Property Age Band          | L                   |                     |
| 4.0 Sheltered Sides            | 2                   |                     |
| 5.0 Sunlight/Shade             | Average or unknown  |                     |
| 6.0 Thermal Mass Parameter     | Precise calculation |                     |
| Thermal Mass                   | N/A                 | kJ/m <sup>2</sup> K |
| 7.0 Electricity Tariff         | Standard            |                     |
| Smart electricity meter fitted | Yes                 |                     |
| Smart gas meter fitted         | Yes                 |                     |

| 7.0 Measurements | Heat Loss Perimeter | Internal Floor Area  | Average Storey Height |
|------------------|---------------------|----------------------|-----------------------|
| Basement:        | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| Ground floor:    | 29.85 m             | 53.56 m <sup>2</sup> | 2.50 m                |
| 1st Storey:      | 29.85 m             | 53.56 m <sup>2</sup> | 2.30 m                |
| 2nd Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 3rd Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 4th Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 5th Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 6th Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 7th Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |

|                 |       |                |
|-----------------|-------|----------------|
| 8.0 Living Area | 40.49 | m <sup>2</sup> |
|-----------------|-------|----------------|

| 9.0 External Walls | Description     | Type         | Construction  | U-Value (W/m <sup>2</sup> K) | Kappa (kJ/m <sup>2</sup> K) | Gross Area(m <sup>2</sup> ) | Nett Area (m <sup>2</sup> ) | Shelter Res | Shelter | Openings | Area Calculation Type |
|--------------------|-----------------|--------------|---|------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------|---------|----------|-----------------------|
|                    | External Wall 1 | Cavity Wall  | Cavity wall; plasterboard on dabs or battens, lightweight aggregate block, filled cavity, any outside structure | 0.15                         | 110.00                      | 128.66                      | 108.16                      | 0.00        | None    | 20.50    | Calculate Wall Area   |
|                    | Dormer Cheek    | Timber Frame | Timber framed wall (one layer of plasterboard)  | 0.21                         | 9.00                        | 14.62                       | 14.62                       | 0.00        | None    | 0.00     | Enter Gross Area      |

| 9.2 Internal Walls | Description | Construction                 | Kappa (kJ/m <sup>2</sup> K) | Area (m <sup>2</sup> ) |
|--------------------|-------------|------------------------------|-----------------------------|------------------------|
|                    | GF          | Plasterboard on timber frame | 9.00                        | 68.13                  |
|                    | FF          | Plasterboard on timber frame | 9.00                        | 90.78                  |

| 10.0 External Roofs | Description | Type                | Construction                             | U-Value (W/m <sup>2</sup> K) | Kappa (kJ/m <sup>2</sup> K) | Gross Area(m <sup>2</sup> ) | Nett Area (m <sup>2</sup> ) | Shelter Code | Shelter Factor | Calculation Type | Openings |
|---------------------|-------------|---------------------|--|------------------------------|-----------------------------|-----------------------------|-----------------------------|--------------|----------------|------------------|----------|
|                     | Cold Roof   | External Plane Roof | Plasterboard, insulated at ceiling level | 0.09                         | 9.00                        | 32.11                       | 32.11                       | None         | 0.00           | Enter Gross Area | 0.00     |

# Summary for Input Data



|              |                     |  |      |      |       |       |      |      |                  |      |
|--------------|---------------------|--|------|------|-------|-------|------|------|------------------|------|
| Sloping Roof | External Plane Roof | Plasterboard, insulated at ceiling level | 0.13 | 9.00 | 15.72 | 14.32 | None | 0.00 | Enter Gross Area | 1.40 |
| Dormer Roof  | External Plane Roof | Plasterboard, insulated at ceiling level | 0.10 | 9.00 | 10.92 | 10.92 | None | 0.00 | Enter Gross Area | 0.00 |

## 10.2 Internal Ceilings

| Description        | Storey          | Construction                                   | Area (m <sup>2</sup> ) |
|--------------------|-----------------|--|------------------------|
| Internal Ceiling 1 | Lowest occupied | Plasterboard ceiling, carpeted chipboard floor | 53.56                  |

## 11.0 Heat Loss Floors

| Description  | Type                 | Storey Index    | Construction                       | U-Value (W/m <sup>2</sup> K) | Shelter Code | Shelter Factor | Kappa (kJ/m <sup>2</sup> K) | Area (m <sup>2</sup> ) |
|--------------|----------------------|-----------------|------------------------------------|------------------------------|--------------|----------------|-----------------------------|------------------------|
| Ground Floor | Ground Floor - Solid | Lowest occupied | Suspended concrete floor, carpeted | 0.12                         | None         | 0.00           | 75.00                       | 53.56                  |

## 11.2 Internal Floors

| Description      | Storey Index | Construction                                   | Kappa (kJ/m <sup>2</sup> K) | Area (m <sup>2</sup> ) |
|------------------|--------------|--|-----------------------------|------------------------|
| Internal Floor 1 |              | Plasterboard ceiling, carpeted chipboard floor | 9.00                        | 53.56                  |

## 12.0 Opening Types

| Description  | Data Source               | Type             | Glazing               | Glazing Gap | Filling Type | G-value | Frame Type | Frame Factor | U Value (W/m <sup>2</sup> K) |
|--------------|---------------------------|------------------|-----------------------|-------------|--------------|---------|------------|--------------|------------------------------|
| Front door   | Manufacturer              | Solid Door       |                       |             | Air Filled   | 0.00    | Wood       | 0.70         | 1.50                         |
| Utility Door | Manufacturer              | Half Glazed Door | Double glazed         |             | Air Filled   | 0.76    | Wood       | 0.70         | 1.20                         |
| Window       | BFRC, BSI or CERTASS data | Window           | Triple Low-E Soft 0.1 |             | Air Filled   | 0.58    | Wood       | 1.00         | 0.80                         |
| French Door  | Manufacturer              | Window           | Double Low-E Soft 0.1 |             | Air Filled   | 0.63    | Wood       | 0.70         | 1.00                         |
| Rooflight    | Manufacturer              | Roof Window      | Double Low-E Soft 0.1 |             | Air Filled   | 0.63    | Wood       | 0.70         | 1.10                         |

## 13.0 Openings

| Name   | Opening Type | Location        | Orientation | Area (m <sup>2</sup> ) | Pitch |
|--------|--------------|-----------------|-------------|------------------------|-------|
| Front  | Front door   | External Wall 1 | South       | 2.12                   | 0     |
| Side R | Utility Door | External Wall 1 | East        | 2.12                   | 0     |
| Rear   | French Door  | External Wall 1 | North       | 5.04                   | 0     |
| Front  | Window       | External Wall 1 | South       | 5.61                   | 0     |
| Front  | Rooflight    | Sloping Roof    | South       | 1.40                   | 45    |
| Side R | Window       | External Wall 1 | East        | 0.76                   | 0     |
| Rear   | Window       | External Wall 1 | North       | 4.85                   | 0     |

## 14.0 Conservatory

## 15.0 Draught Proofing

 %

## 16.0 Draught Lobby

## 17.0 Thermal Bridging

## 17.1 List of Bridges

| Bridge Type                                      | Source Type              | Length | Psi  | Adjusted Reference: | Imported |
|--|--------------------------|--------|------|---------------------|----------|
| E1 Steel lintel with perforated steel base plate | Independently assessed   | 13.77  | 0.05 | 0.05 Hi Therm       | Yes      |
| E3 Sill  | Non Gov Approved Schemes | 9.35   | 0.02 | 0.02 RCD            | No       |
| E4 Jamb  | Non Gov Approved Schemes | 36.00  | 0.02 | 0.02 RCD            | Yes      |
| E5 Ground floor (normal)                         | Non Gov Approved Schemes | 29.85  | 0.11 | 0.11 RCD            | Yes      |
| E6 Intermediate floor within a dwelling          | Non Gov Approved Schemes | 29.85  | 0.00 | 0.00 RCD            | Yes      |
| E16 Corner (normal)                              | Non Gov Approved Schemes | 17.20  | 0.05 | 0.05 RCD            | No       |
| R1 Head of roof window                           | Table K1 - Default       | 1.27   | 0.24 | 0.24                | Yes      |
| R2 Sill of roof window                           | Table K1 - Default       | 1.27   | 0.24 | 0.24                | Yes      |
| R3 Jamb of roof window                           | Table K1 - Default       | 2.20   | 0.24 | 0.24                | Yes      |
| E10 Eaves (insulation at ceiling level)          | Non Gov Approved Schemes | 9.65   | 0.06 | 0.06 RCD            | No       |
| E11 Eaves (insulation at rafter level)           | Non Gov Approved Schemes | 8.51   | 0.02 | 0.02 RCD            | No       |
| E12 Gable (insulation at ceiling level)          | Non Gov Approved Schemes | 16.29  | 0.10 | 0.10 RCD            | No       |
| E13 Gable (insulation at rafter level)           | Non Gov Approved Schemes | 4.83   | 0.05 | 0.05 RCD            | No       |
| R6 Flat ceiling                                  | Independently assessed   | 8.83   | 0.06 | 0.06 TBC            | No       |
| R7 Flat ceiling (inverted)                       | Independently assessed   | 18.68  | 0.06 | 0.06 TBC            | No       |
| R9 Roof to wall (flat ceiling)                   | Independently assessed   | 9.03   | 0.16 | 0.16 TBC            | No       |

Y-value  W/m<sup>2</sup>K

## 18.0 Pressure Testing

Designed AP<sub>50</sub>  m<sup>3</sup>/(h.m<sup>2</sup>) @ 50 Pa

Property Tested?

Test Method

## 19.0 Mechanical Ventilation

### Mechanical Ventilation

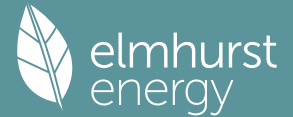
Mechanical Ventilation System Present

Approved Installation

Mechanical Ventilation data Type

Type

# Summary for Input Data



|  |  |
|--|--|
| MV Reference Number                          | 500480   |
| Configuration                                | 3  |
| Manufacturer SFP                             | 0.57   |
| Duct Type                                    | Rigid  |
| MVHR Efficiency                              | 94.00  |
| Wet Rooms                                    | 3  |
| SFP from Installer Commissioning Certificate | No   |
| MVHR System Location                         | Inside heated envelope (installed exclusively) |
| Duct Installation Specification              | Level 1  |

## 19.1 Mechanical extract ventilation - Decentralised

| SFP  | Fan/Room Type                      | Count |
|------|------------------------------------|-------|
| 0.15 | In Room Fan<br>Kitchen             | 1     |
| 0.11 | In Room Fan Other<br>Wet Room      | 0     |
| 0.00 | In Duct Fan Kitchen                | 0     |
| 0.00 | In Duct Fan Other<br>Wet Room      | 0     |
| 0.11 | Through Wall Fan<br>Kitchen        | 3     |
| 0.09 | Through Wall Fan<br>Other Wet Room | 0     |

## 20.0 Fans, Open Fireplaces, Flues

### 21.0 Fixed Cooling System

No

### 22.0 Lighting

No Fixed Lighting

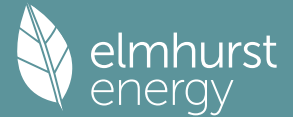
No

| Name       | Efficacy | Power | Capacity | Count |
|------------|----------|-------|----------|-------|
| Lighting 1 | 75.00    | 10    | 750      | 40    |

### 24.0 Main Heating 1

|                        |                          |   |
|------------------------|--------------------------|---|
| Database               |                          |   |
| Percentage of Heat     | 100.00                   | % |
| Database Ref. No.      | 104436                   |   |
| Fuel Type              | Electricity              |   |
| SAP Code               | 0                        |   |
| In Winter              | 273.84                   |   |
| In Summer              | 284.35                   |   |
| Model Name             | aroTHERM plus 7kW + AI   |   |
| Manufacturer           | Vaillant Group UK Ltd    |   |
| System Type            | Heat Pump                |   |
| Controls SAP Code      | 2207                     |   |
| Delayed Start Stat     | No                       |   |
| Burner Control         | Modulating               |   |
| HETAS approved System  | No                       |   |
| Oil Pump Inside        | No                       |   |
| FI Case                | 0.00                     |   |
| Flue Type              | None or Unknown          |   |
| Smoke Control Area     | Unknown                  |   |
| Fan Assisted Flue      | No                       |   |
| Is MHS Pumped          | Pump in heated space     |   |
| Heating Pump Age       | 2013 or later            |   |
| Heat Emitter           | Radiators and Underfloor |   |
| Underfloor Heating     | Yes - Pipes in Wood      |   |
| Flow Temperature       | Enter value              |   |
| Flow Temperature Value | 45.00                    |   |

# Summary for Input Data



Boiler Interlock

Combi boiler type

Combi keep hot type

**25.0 Main Heating 2**

**26.0 Heat Networks**

| Heat Source   | Fuel Type | Heating Use | Efficiency | Percentage Of Heat | Heat | Heat Power Ratio | Electrical | Fuel Factor | Efficiency type |
|---------------|-----------|-------------|------------|--------------------|------|------------------|------------|-------------|-----------------|
| Heat source 1 | None      |             |            |                    |      |                  |            |             |                 |
| Heat source 2 | None      |             |            |                    |      |                  |            |             |                 |
| Heat source 3 | None      |             |            |                    |      |                  |            |             |                 |
| Heat source 4 | None      |             |            |                    |      |                  |            |             |                 |
| Heat source 5 | None      |             |            |                    |      |                  |            |             |                 |

## 27.0 Secondary Heating

Secondary Heating

SAP Code

SHS efficiency  %

HETAS Approved System

Smoke Control Area

## 28.0 Water Heating

Water Heating

SAP Code

Flue Gas Heat Recovery System

Waste Water Heat Recovery Instantaneous System 1

Waste Water Heat Recovery Instantaneous System 2

Waste Water Heat Recovery Storage System

Solar Panel

Water use <= 125 litres/person/day

Summer Immersion

Cold Water Source

Bath Count

Supplementary Immersion

Immersion Only Heating Hot Water

## 28.1 Showers

| Description | Shower Type                               | Flow Rate [l/min] | Rated Power [kW] | Connected | Connected To |
|-------------|---|-------------------|------------------|-----------|--------------|
| Bathroom    | Combi boiler or unvented hot water system | 8.00              |                  | No        |              |
| Ensuite     | Combi boiler or unvented hot water system | 8.00              |                  | No        |              |

## 28.3 Waste Water Heat Recovery System

## 29.0 Hot Water Cylinder

Cylinder Stat

Cylinder In Heated Space

Independent Time Control

Insulation Type

Cylinder Volume  L

Loss  kWh/day

Pipes insulation

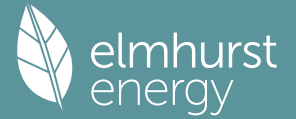
In Airing Cupboard

**31.0 Thermal Store**

**32.0 Photovoltaic Unit**

Export Capable Meter?

# Summary for Input Data



Connected To Dwelling

Diverter

Battery Capacity [kWh]

| PV Cells kWp | Orientation | Elevation | Overshading    | FGHRS | MCS Certificate | Overshading Factor | MCS Certificate Reference | Panel Manufacturer |
|--------------|-------------|-----------|----------------|-------|-----------------|--------------------|---------------------------|--------------------|
| 3.20         | South       | 45°       | None Or Little | No    | No              | 1.00               |                           |                    |

**34.0 Small-scale Hydro**

Electricity Generated

Apportioned  kWh/Year

Connected to dwelling's electricity meter

Electricity Generation

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

**Recommendations**

**Lower cost measures**

None

**Further measures to achieve even higher standards**

None

# Summary for Input Data



|                                    |   |               |                |             |           |
|------------------------------------|---|---------------|----------------|-------------|-----------|
| Property Reference                 | Plot 2  |               | Issued on Date | 21/12/2023  |           |
| Assessment Reference               | 00001   | Prop Type Ref | Plot 2         |             |           |
| Property                           | Plot 2, Ryeland, Trevanna Cross, St Mawgan, Cornwall, TR8 4HB |               |                |             |           |
| SAP Rating                         | 98 A  | DER           | -0.36          | TER         | 10.47     |
| Environmental                      | 100 A   | % DER < TER   |                |             | 103.44    |
| CO <sub>2</sub> Emissions (t/year) | -0.17   | DFEE          | 37.83          | TFEE        | 44.67     |
| Compliance Check                   | See BREL  | % DFEE < TFEE |                |             | 15.32     |
| % DPER < TPER                      | 86.45   | DPER          | 7.44           | TPER        | 54.91     |
| Assessor Details                   | Mr. Matthew Fitzpatrick                                       |               |                | Assessor ID | 7601-0001 |
| Client                             |   |               |                |             |           |

## SUMMARY FOR INPUT DATA FOR: New Build (As Designed)

|                                |                     |                     |
|--------------------------------|---------------------|---------------------|
| Orientation                    | North               |                     |
| Property Tenure                | 1                   |                     |
| Transaction Type               | 6                   |                     |
| Terrain Type                   | Rural               |                     |
| 1.0 Property Type              | House, Detached     |                     |
| Which Floor                    | 0                   |                     |
| 2.0 Number of Storeys          | 2                   |                     |
| 3.0 Date Built                 | 2023                |                     |
| 3.0 Property Age Band          | L                   |                     |
| 4.0 Sheltered Sides            | 2                   |                     |
| 5.0 Sunlight/Shade             | Average or unknown  |                     |
| 6.0 Thermal Mass Parameter     | Precise calculation |                     |
| Thermal Mass                   | N/A                 | kJ/m <sup>2</sup> K |
| 7.0 Electricity Tariff         | Standard            |                     |
| Smart electricity meter fitted | Yes                 |                     |
| Smart gas meter fitted         | Yes                 |                     |

| 7.0 Measurements | Heat Loss Perimeter | Internal Floor Area  | Average Storey Height |
|------------------|---------------------|----------------------|-----------------------|
| Basement:        | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| Ground floor:    | 37.60 m             | 74.72 m <sup>2</sup> | 2.50 m                |
| 1st Storey:      | 37.19 m             | 65.15 m <sup>2</sup> | 2.30 m                |
| 2nd Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 3rd Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 4th Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 5th Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 6th Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |
| 7th Storey:      | 0.00 m              | 0.00 m <sup>2</sup>  | 0.00 m                |

|                 |       |                |
|-----------------|-------|----------------|
| 8.0 Living Area | 46.42 | m <sup>2</sup> |
|-----------------|-------|----------------|

| 9.0 External Walls | Description     | Type         | Construction  | U-Value (W/m <sup>2</sup> K) | Kappa (kJ/m <sup>2</sup> K) | Gross Area(m <sup>2</sup> ) | Nett Area (m <sup>2</sup> ) | Shelter Res | Shelter | Openings | Area Calculation Type |
|--------------------|-----------------|--------------|---|------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------|---------|----------|-----------------------|
|                    | External Wall 1 | Cavity Wall  | Cavity wall; plasterboard on dabs or battens, lightweight aggregate block, filled cavity, any outside structure | 0.15                         | 110.00                      | 165.16                      | 131.49                      | 0.00        | None    | 33.67    | Enter Gross Area      |
|                    | Dormer Cheek    | Timber Frame | Timber framed wall (one layer of plasterboard)  | 0.21                         | 9.00                        | 6.00                        | 6.00                        | 0.00        | None    | 0.00     | Enter Gross Area      |

| 9.2 Internal Walls | Description | Construction                      | Kappa (kJ/m <sup>2</sup> K) | Area (m <sup>2</sup> ) |
|--------------------|-------------|-----------------------------------|-----------------------------|------------------------|
|                    | GF          | Plasterboard on timber frame      | 9.00                        | 50.53                  |
|                    | FF          | Plasterboard on timber frame      | 9.00                        | 118.69                 |
|                    | GF Block    | Dense block, plasterboard on dabs | 75.00                       | 54.21                  |

| 10.0 External Roofs | Description | Type                | Construction                             | U-Value (W/m <sup>2</sup> K) | Kappa (kJ/m <sup>2</sup> K) | Gross Area(m <sup>2</sup> ) | Nett Area (m <sup>2</sup> ) | Shelter Code | Shelter Factor | Calculation Type | Openings |
|---------------------|-------------|---------------------|--|------------------------------|-----------------------------|-----------------------------|-----------------------------|--------------|----------------|------------------|----------|
|                     | Cold Roof   | External Plane Roof | Plasterboard, insulated at ceiling level | 0.09                         | 9.00                        | 23.87                       | 23.87                       | None         | 0.00           | Enter Gross Area | 0.00     |

# Summary for Input Data



|              |                     |  |      |      |       |       |      |      |                  |      |
|--------------|---------------------|--|------|------|-------|-------|------|------|------------------|------|
| Sloping Roof | External Plane Roof | Plasterboard, insulated at ceiling level | 0.13 | 9.00 | 65.80 | 61.46 | None | 0.00 | Enter Gross Area | 4.34 |
| Dormer Roof  | External Plane Roof | Plasterboard, insulated at ceiling level | 0.10 | 9.00 | 4.01  | 4.01  | None | 0.00 | Enter Gross Area | 0.00 |

## 10.2 Internal Ceilings

| Description        | Storey          | Construction                                   | Area (m <sup>2</sup> ) |
|--------------------|-----------------|--|------------------------|
| Internal Ceiling 1 | Lowest occupied | Plasterboard ceiling, carpeted chipboard floor | 65.15                  |

## 11.0 Heat Loss Floors

| Description  | Type                 | Storey Index    | Construction                       | U-Value (W/m <sup>2</sup> K) | Shelter Code | Shelter Factor | Kappa (kJ/m <sup>2</sup> K) | Area (m <sup>2</sup> ) |
|--------------|----------------------|-----------------|------------------------------------|------------------------------|--------------|----------------|-----------------------------|------------------------|
| Ground Floor | Ground Floor - Solid | Lowest occupied | Suspended concrete floor, carpeted | 0.12                         | None         | 0.00           | 75.00                       | 74.72                  |

## 11.2 Internal Floors

| Description      | Storey Index | Construction                                   | Kappa (kJ/m <sup>2</sup> K) | Area (m <sup>2</sup> ) |
|------------------|--------------|--|-----------------------------|------------------------|
| Internal Floor 1 |              | Plasterboard ceiling, carpeted chipboard floor | 9.00                        | 65.15                  |

## 12.0 Opening Types

| Description  | Data Source               | Type             | Glazing                | Glazing Gap | Filling Type | G-value | Frame Type | Frame Factor | U Value (W/m <sup>2</sup> K) |
|--------------|---------------------------|------------------|------------------------|-------------|--------------|---------|------------|--------------|------------------------------|
| Front door   | Manufacturer              | Solid Door       |                        |             | Air Filled   | 0.00    | Wood       | 0.70         | 1.20                         |
| Utility Door | Manufacturer              | Half Glazed Door | Double glazed          |             | Air Filled   | 0.76    | Wood       | 0.70         | 1.20                         |
| Window       | BFRC, BSI or CERTASS data | Window           | Triple Low-E Hard 0.2  |             | Air Filled   | 0.39    | Wood       | 1.00         | 0.80                         |
| Patio Door   | Manufacturer              | Window           | Triple Low-E Hard 0.15 |             | Air Filled   | 0.58    | Wood       | 0.70         | 1.00                         |
| Rooflight    | Manufacturer              | Roof Window      | Double Low-E Soft 0.1  |             | Air Filled   | 0.63    | Wood       | 0.70         | 1.10                         |

## 13.0 Openings

| Name   | Opening Type | Location        | Orientation | Area (m <sup>2</sup> ) | Pitch |
|--------|--------------|-----------------|-------------|------------------------|-------|
| Front  | Front door   | External Wall 1 | South       | 3.15                   | 0     |
| Front  | Utility Door | External Wall 1 | South       | 2.12                   | 0     |
| Rear   | Patio Door   | External Wall 1 | North       | 12.60                  | 0     |
| Front  | Window       | External Wall 1 | South       | 6.08                   | 0     |
| Front  | Rooflight    | Sloping Roof    | South       | 1.40                   | 45    |
| Side R | Window       | External Wall 1 | East        | 1.51                   | 0     |
| Rear   | Window       | External Wall 1 | North       | 5.94                   | 0     |
| Side L | Window       | External Wall 1 | East        | 2.27                   | 0     |
| Side   | Rooflight    | Sloping Roof    | South       | 0.74                   | 45    |
| Rear   | Rooflight    | Sloping Roof    | North       | 2.21                   | 45    |

## 14.0 Conservatory

## 15.0 Draught Proofing

 %

## 16.0 Draught Lobby

## 17.0 Thermal Bridging

## 17.1 List of Bridges

| Bridge Type  | Source Type              | Length | Psi   | Adjusted Reference: | Imported |
|--|--------------------------|--------|-------|---------------------|----------|
| E1 Steel lintel with perforated steel base plate                 | Independently assessed   | 19.39  | 0.05  | 0.05 Hi Therm       | No       |
| E3 Sill  | Non Gov Approved Schemes | 14.42  | 0.02  | 0.02 RCD            | No       |
| E4 Jamb  | Non Gov Approved Schemes | 56.10  | 0.02  | 0.02 RCD            | No       |
| E5 Ground floor (normal)   | Non Gov Approved Schemes | 37.60  | 0.12  | 0.12 RCD            | No       |
| E6 Intermediate floor within a dwelling                          | Non Gov Approved Schemes | 34.00  | 0.00  | 0.00 RCD            | No       |
| E16 Corner (normal)  | Non Gov Approved Schemes | 29.20  | 0.04  | 0.04 RCD            | No       |
| R1 Head of roof window   | Table K1 - Default       | 3.95   | 0.24  | 0.24                | No       |
| R2 Sill of roof window   | Table K1 - Default       | 3.95   | 0.24  | 0.24                | No       |
| R3 Jamb of roof window   | Table K1 - Default       | 11.00  | 0.24  | 0.24                | No       |
| E10 Eaves (insulation at ceiling level)                          | Non Gov Approved Schemes | 5.21   | 0.07  | 0.07 RCD            | No       |
| E11 Eaves (insulation at rafter level)                           | Non Gov Approved Schemes | 26.00  | 0.03  | 0.03 RCD            | No       |
| E12 Gable (insulation at ceiling level)                          | Non Gov Approved Schemes | 8.08   | 0.10  | 0.10 RCD            | No       |
| E13 Gable (insulation at rafter level)                           | Non Gov Approved Schemes | 15.89  | 0.06  | 0.06 RCD            | No       |
| R6 Flat ceiling  | Independently assessed   | 17.93  | 0.06  | 0.06 TBC            | No       |
| R7 Flat ceiling (inverted)                                       | Independently assessed   | 5.67   | 0.06  | 0.06 TBC            | No       |
| E17 Corner (inverted – internal area greater than external area) | Non Gov Approved Schemes | 10.00  | -0.07 | -0.07               | No       |

Y-value  W/m<sup>2</sup>K

## 18.0 Pressure Testing

Designed AP<sub>50</sub>  m<sup>3</sup>/(h.m<sup>2</sup>) @ 50 Pa

Property Tested?

Test Method

## 19.0 Mechanical Ventilation

### Mechanical Ventilation

Mechanical Ventilation System Present

Approved Installation

# Summary for Input Data



|  |  |
|--|--|
| Mechanical Ventilation data Type             | Database   |
| Type   | Balanced mechanical ventilation with heat recovery |
| MV Reference Number                          | 500481   |
| Configuration                                | 3  |
| Manufacturer SFP                             | 0.55   |
| Duct Type                                    | Rigid  |
| MVHR Efficiency                              | 94.00  |
| Wet Rooms                                    | 3  |
| SFP from Installer Commissioning Certificate | No   |
| MVHR System Location                         | Inside heated envelope (installed exclusively)     |
| Duct Installation Specification              | Level 1  |

## 19.1 Mechanical extract ventilation - Decentralised

| SFP  | Fan/Room Type                      | Count |
|------|------------------------------------|-------|
| 0.15 | In Room Fan<br>Kitchen             | 1     |
| 0.11 | In Room Fan Other<br>Wet Room      | 3     |
| 0.00 | In Duct Fan Kitchen                | 0     |
| 0.00 | In Duct Fan Other<br>Wet Room      | 0     |
| 0.11 | Through Wall Fan<br>Kitchen        | 0     |
| 0.09 | Through Wall Fan<br>Other Wet Room | 0     |

## 20.0 Fans, Open Fireplaces, Flues

|                           |    |
|---------------------------|----|
| 21.0 Fixed Cooling System | No |
|---------------------------|----|

## 22.0 Lighting

| No Fixed Lighting | No         |          |       |          |       |
|-------------------|------------|----------|-------|----------|-------|
|                   | Name       | Efficacy | Power | Capacity | Count |
|                   | Lighting 1 | 75.00    | 10    | 750      | 40    |

## 24.0 Main Heating 1

|                       |                          |   |
|-----------------------|--------------------------|---|
|                       | Database                 |   |
| Percentage of Heat    | 100.00                   | % |
| Database Ref. No.     | 104436                   |   |
| Fuel Type             | Electricity              |   |
| SAP Code              | 0                        |   |
| In Winter             | 263.88                   |   |
| In Summer             | 279.38                   |   |
| Model Name            | aroTHERM plus 7kW + AI   |   |
| Manufacturer          | Vaillant Group UK Ltd    |   |
| System Type           | Heat Pump                |   |
| Controls SAP Code     | 2207                     |   |
| Delayed Start Stat    | No                       |   |
| Burner Control        | Modulating               |   |
| HETAS approved System | No                       |   |
| Oil Pump Inside       | No                       |   |
| FI Case               | 0.00                     |   |
| Flue Type             | None or Unknown          |   |
| Smoke Control Area    | Unknown                  |   |
| Fan Assisted Flue     | No                       |   |
| Is MHS Pumped         | Pump in heated space     |   |
| Heating Pump Age      | 2013 or later            |   |
| Heat Emitter          | Radiators and Underfloor |   |
| Underfloor Heating    | Yes - Pipes in Wood      |   |



# Summary for Input Data



|                        |   |
|------------------------|---|
| Flow Temperature       | <input type="text" value="Enter value"/>    |
| Flow Temperature Value | <input type="text" value="45.00"/>          |
| Boiler Interlock       | <input type="text" value="No"/>             |
| Combi boiler type      | <input type="text" value="Standard Combi"/> |
| Combi keep hot type    | <input type="text" value="None"/>           |

**25.0 Main Heating 2**

**26.0 Heat Networks**

**27.0 Secondary Heating**

|                       |  |
|-----------------------|--|
| Secondary Heating     | <input type="text" value="SAP table"/> |
| SAP Code              | <input type="text" value="633"/>       |
| SHS efficiency        | <input type="text" value="60.00"/> %   |
| HETAS Approved System | <input type="text" value="Yes"/>       |
| Smoke Control Area    | <input type="text" value="Unknown"/>   |

**28.0 Water Heating**

|  |   |
|--|---|
| Water Heating                                    | <input type="text" value="Main Heating 1"/> |
| SAP Code   | <input type="text" value="901"/>            |
| Flue Gas Heat Recovery System                    | <input type="text" value="No"/>             |
| Waste Water Heat Recovery Instantaneous System 1 | <input type="text" value="No"/>             |
| Waste Water Heat Recovery Instantaneous System 2 | <input type="text" value="No"/>             |
| Waste Water Heat Recovery Storage System         | <input type="text" value="No"/>             |
| Solar Panel                                      | <input type="text" value="No"/>             |
| Water use <= 125 litres/person/day               | <input type="text" value="Yes"/>            |
| Summer Immersion                                 | <input type="text" value="No"/>             |
| Cold Water Source                                | <input type="text" value="From mains"/>     |
| Bath Count                                       | <input type="text" value="1"/>              |
| Supplementary Immersion                          | <input type="text" value="No"/>             |
| Immersion Only Heating Hot Water                 | <input type="text" value="No"/>             |

**28.1 Showers**

| Description | Shower Type                               | Flow Rate [l/min] | Rated Power [kW] | Connected | Connected To |
|-------------|---|-------------------|------------------|-----------|--------------|
| Bathroom    | Combi boiler or unvented hot water system | 8.00              |                  | No        |              |
| Ensuite     | Combi boiler or unvented hot water system | 8.00              |                  | No        |              |

**28.3 Waste Water Heat Recovery System**

**29.0 Hot Water Cylinder**

|                          |   |
|--------------------------|---|
| Hot Water Cylinder       | <input type="text" value="Hot Water Cylinder"/>               |
| Cylinder Stat            | <input type="text" value="Yes"/>                              |
| Cylinder In Heated Space | <input type="text" value="Yes"/>                              |
| Independent Time Control | <input type="text" value="Yes"/>                              |
| Insulation Type          | <input type="text" value="Measured Loss"/>                    |
| Cylinder Volume          | <input type="text" value="250.00"/> L                         |
| Loss                     | <input type="text" value="1.40"/> kWh/day                     |
| Pipes insulation         | <input type="text" value="Fully insulated primary pipework"/> |
| In Airing Cupboard       | <input type="text" value="No"/>                               |

**31.0 Thermal Store**

**32.0 Photovoltaic Unit**

|                        |   |
|------------------------|---|
| One Dwelling           | <input type="text" value="One Dwelling"/> |
| Export Capable Meter?  | <input type="text" value="Yes"/>          |
| Connected To Dwelling  | <input type="text" value="Yes"/>          |
| Diverter               | <input type="text" value="No"/>           |
| Battery Capacity [kWh] | <input type="text" value="0.00"/>         |

# Summary for Input Data



| PV Cells kWp | Orientation | Elevation | Overshading    | FGHRS | MCS Certificate | Overshading Factor | MCS Certificate Reference | Panel Manufacturer |
|--------------|-------------|-----------|----------------|-------|-----------------|--------------------|---------------------------|--------------------|
| 4.00         | South       | 45°       | None Or Little | No    | No              | 1.00               |                           |                    |

## 34.0 Small-scale Hydro

|   |        |          |
|---|--------|----------|
| Electricity Generated                     | None   |          |
| Apportioned                               | 0.00   | kWh/Year |
| Connected to dwelling's electricity meter | 0.00   |          |
| Electricity Generation                    | Yes    |          |
|   | Annual |          |

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

## Recommendations

Lower cost measures

None

Further measures to achieve even higher standards

None

# Full SAP Calculation Printout



|                                    |   |               |                |             |           |
|------------------------------------|---|---------------|----------------|-------------|-----------|
| Property Reference                 | Plot 1  |               | Issued on Date | 21/12/2023  |           |
| Assessment Reference               | 00001   | Prop Type Ref | Plot 1         |             |           |
| Property                           | Plot 1, Ryeland, Trevanna Cross, St Mawgan, Cornwall, TR8 4HB |               |                |             |           |
| SAP Rating                         | 98 A  | DER           | -0.39          | TER         | 11.24     |
| Environmental                      | 100 A   | % DER < TER   |                |             | 103.47    |
| CO <sub>2</sub> Emissions (t/year) | -0.13   | DFEE          | 33.21          | TFEE        | 41.23     |
| Compliance Check                   | See BREL  | % DFEE < TFEE |                |             | 19.46     |
| % DPER < TPER                      | 87.38   | DPER          | 7.41           | TPER        | 58.75     |
| Assessor Details                   | Mr. Matthew Fitzpatrick                                       |               |                | Assessor ID | 7601-0001 |
| Client                             |   |               |                |             |           |

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)  
CALCULATION OF ENERGY RATING

### 1. Overall dwelling characteristics

|  | Area (m <sup>2</sup> ) | Storey height (m)               | Volume (m <sup>3</sup> ) |
|--|------------------------|---------------------------------|--------------------------|
| Ground floor   | 53.5600 (1b)           | x 2.5000 (2b)                   | = 133.9000 (1b) - (3b)   |
| First floor  | 53.5600 (1c)           | x 2.3000 (2c)                   | = 123.1880 (1c) - (3c)   |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 107.1200               |                                 | (4)                      |
| Dwelling volume  |                        | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 257.0880 (5)           |

### 2. Ventilation rate

|  | m <sup>3</sup> per hour                 |
|--|---|
| Number of open chimneys  | 0 * 80 = 0.0000 (6a)                    |
| Number of open flues   | 1 * 20 = 20.0000 (6b)                   |
| Number of chimneys / flues attached to closed fire   | 0 * 10 = 0.0000 (6c)                    |
| Number of flues attached to solid fuel boiler  | 0 * 20 = 0.0000 (6d)                    |
| Number of flues attached to other heater   | 0 * 35 = 0.0000 (6e)                    |
| Number of blocked chimneys   | 0 * 20 = 0.0000 (6f)                    |
| Number of intermittent extract fans  | 0 * 10 = 0.0000 (7a)                    |
| Number of passive vents  | 0 * 10 = 0.0000 (7b)                    |
| Number of flueless gas fires   | 0 * 40 = 0.0000 (7c)                    |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 20.0000 / (5) = 0.0778 (8)              |
| Pressure test  | Yes                                     |
| Pressure Test Method   | Blower Door                             |
| Measured/design AP50   | 3.0000 (17)                             |
| Infiltration rate  | 0.2278 (18)                             |
| Number of sides sheltered  | 2 (19)                                  |
| Shelter factor   | (20) = 1 - [0.075 x (19)] = 0.8500 (20) |
| Infiltration rate adjusted to include shelter factor   | (21) = (18) x (20) = 0.1936 (21)        |

|   | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec           |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------------|
| Wind speed  | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)   |
| Wind factor   | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a)  |
| Adj infilt rate   | 0.2469 | 0.2420 | 0.2372 | 0.2130 | 0.2081 | 0.1839 | 0.1839 | 0.1791 | 0.1936 | 0.2081 | 0.2178 | 0.2275 (22b)  |
| Balanced mechanical ventilation with heat recovery  |        |        |        |        |        |        |        |        |        |        |        |               |
| If mechanical ventilation   |        |        |        |        |        |        |        |        |        |        |        | 0.5000 (23a)  |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |        |        |        |        |        |        |        |        |        |        |        | 0.5000 (23b)  |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |        |        |        |        |        |        |        |        |        |        |        | 84.6000 (23c) |
| Effective ac  | 0.3239 | 0.3190 | 0.3142 | 0.2900 | 0.2851 | 0.2609 | 0.2609 | 0.2561 | 0.2706 | 0.2851 | 0.2948 | 0.3045 (25)   |

### 3. Heat losses and heat loss parameter

| Element   | Gross m <sup>2</sup> | Openings m <sup>2</sup> | NetArea m <sup>2</sup> | U-value W/m <sup>2</sup> K | A x U W/K | K-value kJ/m <sup>2</sup> K | A x K kJ/K       |
|---|----------------------|-------------------------|------------------------|----------------------------|-----------|-----------------------------|------------------|
| Front door  |                      |                         | 2.1200                 | 1.5000                     | 3.1800    |                             | (26)             |
| Utility Door  |                      |                         | 2.1200                 | 1.2000                     | 2.5440    |                             | (26a)            |
| Window (Uw = 0.80)  |                      |                         | 11.2200                | 0.7752                     | 8.6977    |                             | (27)             |
| French Door (Uw = 1.00)                                     |                      |                         | 5.0400                 | 0.9615                     | 4.8462    |                             | (27)             |
| Front   |                      |                         | 1.4000                 | 1.0536                     | 1.4751    |                             | (27a)            |
| Ground Floor  |                      |                         | 53.5600                | 0.1200                     | 6.4272    | 75.0000                     | 4017.0000 (28a)  |
| External Wall 1   | 128.6600             | 20.5000                 | 108.1600               | 0.1500                     | 16.2240   | 110.0000                    | 11897.6000 (29a) |
| Dormer Cheek  | 14.6200              |                         | 14.6200                | 0.2100                     | 3.0702    | 9.0000                      | 131.5800 (29a)   |
| Cold Roof   | 32.1100              |                         | 32.1100                | 0.0900                     | 2.8899    | 9.0000                      | 288.9900 (30)    |
| Sloping Roof  | 15.7200              | 1.4000                  | 14.3200                | 0.1300                     | 1.8616    | 9.0000                      | 128.8800 (30)    |
| Dormer Roof   | 10.9200              |                         | 10.9200                | 0.1000                     | 1.0920    | 9.0000                      | 98.2800 (30)     |
| Total net area of external elements Aum(A, m <sup>2</sup> ) |                      |                         | 255.5900               |                            |           |                             | (31)             |
| Fabric heat loss, W/K = Sum (A x U)                         |                      |                         |                        | (26)...(30) + (32) =       | 52.3078   |                             | (33)             |
| GF  |                      |                         | 68.1300                |                            |           | 9.0000                      | 613.1700 (32c)   |

# Full SAP Calculation Printout



|                    |         |         |                |
|--------------------|---------|---------|----------------|
| FF                 | 90.7800 | 9.0000  | 817.0200 (32c) |
| Internal Floor 1   | 53.5600 | 18.0000 | 964.0800 (32d) |
| Internal Ceiling 1 | 53.5600 | 9.0000  | 482.0400 (32e) |

Heat capacity Cm = Sum(A x k)  
 Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K (28)...(30) + (32) + (32a)...(32e) = 19438.6400 (34)  
 List of Thermal Bridges 181.4660 (35)

| K1 Element                                       | Length  | Psi-value | Total  |
|--|---------|-----------|--------|
| E1 Steel lintel with perforated steel base plate | 13.7700 | 0.0500    | 0.6885 |
| E3 Sill  | 9.3500  | 0.0210    | 0.1963 |
| E4 Jamb  | 36.0000 | 0.0160    | 0.5760 |
| E5 Ground floor (normal)                         | 29.8500 | 0.1120    | 3.3432 |
| E6 Intermediate floor within a dwelling          | 29.8500 | 0.0020    | 0.0597 |
| E16 Corner (normal)                              | 17.2000 | 0.0510    | 0.8772 |
| R1 Head of roof window                           | 1.2700  | 0.2400    | 0.3048 |
| R2 Sill of roof window                           | 1.2700  | 0.2400    | 0.3048 |
| R3 Jamb of roof window                           | 2.2000  | 0.2400    | 0.5280 |
| E10 Eaves (insulation at ceiling level)          | 9.6500  | 0.0630    | 0.6079 |
| E11 Eaves (insulation at rafter level)           | 8.5100  | 0.0170    | 0.1447 |
| E12 Gable (insulation at ceiling level)          | 16.2900 | 0.0980    | 1.5964 |
| E13 Gable (insulation at rafter level)           | 4.8300  | 0.0510    | 0.2463 |
| R6 Flat ceiling                                  | 8.8300  | 0.0600    | 0.5298 |
| R7 Flat ceiling (inverted)                       | 18.6800 | 0.0600    | 1.1208 |
| R9 Roof to wall (flat ceiling)                   | 9.0300  | 0.1600    | 1.4448 |

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 12.5693 (36)  
 Point Thermal bridges (36a) = 0.0000  
 Total fabric heat loss (33) + (36) + (36a) = 64.8771 (37)

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

| (38)m                     | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
|---------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Heat transfer coeff       | 27.4770 | 27.0663 | 26.6557 | 24.6023 | 24.1916 | 22.1382 | 22.1382 | 21.7276 | 22.9596 | 24.1916 | 25.0130 | 25.8343 (38) |
| Average = Sum(39)m / 12 = | 92.3541 | 91.9435 | 91.5328 | 89.4794 | 89.0688 | 87.0154 | 87.0154 | 86.6047 | 87.8367 | 89.0688 | 89.8901 | 90.7114 (39) |
|                           |         |         |         |         |         |         |         |         |         |         |         | 89.3768      |

| HLP           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec         |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| HLP (average) | 0.8622 | 0.8583 | 0.8545 | 0.8353 | 0.8315 | 0.8123 | 0.8123 | 0.8085 | 0.8200 | 0.8315 | 0.8392 | 0.8468 (40) |
| Days in mont  | 31     | 28     | 31     | 30     | 31     | 30     | 31     | 31     | 30     | 31     | 30     | 31          |

#### 4. Water heating energy requirements (kWh/year)

Assumed occupancy 2.7964 (42)

| Hot water usage for mixer showers        | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec           |
|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------------|
| Hot water usage for mixer showers        | 71.1060 | 70.0375 | 68.4803 | 65.5010 | 63.3024 | 60.8504 | 59.4568 | 61.0021 | 62.6961 | 65.3287 | 68.3720 | 70.8336 (42a) |
| Hot water usage for baths                | 30.7011 | 30.2452 | 29.6031 | 28.4192 | 27.5328 | 26.5498 | 26.0188 | 26.6564 | 27.3507 | 28.4025 | 29.6107 | 30.5974 (42b) |
| Hot water usage for other uses           | 43.2678 | 41.6944 | 40.1211 | 38.5477 | 36.9743 | 35.4009 | 35.4009 | 36.9743 | 38.5477 | 40.1211 | 41.6944 | 43.2678 (42c) |
| Average daily hot water use (litres/day) |         |         |         |         |         |         |         |         |         |         |         | 133.3566 (43) |

| Daily hot water use                    | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec                          |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|------------------------------|
| Daily hot water use                    | 145.0750 | 141.9771 | 138.2045 | 132.4679 | 127.8094 | 122.8012 | 120.8766 | 124.6329 | 128.5945 | 133.8523 | 139.6772 | 144.6988 (44)                |
| Energy conte                           | 229.7633 | 202.1735 | 212.4151 | 181.3420 | 172.0561 | 150.9984 | 146.1897 | 154.3215 | 158.5698 | 181.6362 | 198.9958 | 226.5633 (45)                |
| Energy content (annual)                |          |          |          |          |          |          |          |          |          |          |          | Total = Sum(45)m = 2215.0247 |
| Distribution loss (46)m = 0.15 x (45)m | 34.4645  | 30.3260  | 31.8623  | 27.2013  | 25.8084  | 22.6498  | 21.9285  | 23.1482  | 23.7855  | 27.2454  | 29.8494  | 33.9845 (46)                 |

Water storage loss:  
 Store volume 250.0000 (47)  
 a) If manufacturer declared loss factor is known (kWh/day): 1.4000 (48)  
 Temperature factor from Table 2b 0.5400 (49)  
 Enter (49) or (54) in (55) 0.7560 (55)  
 Total storage loss

|  | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| 23.4360                                      | 21.1680 | 23.4360 | 22.6800 | 23.4360 | 22.6800 | 23.4360 | 23.4360 | 22.6800 | 23.4360 | 22.6800 | 23.4360 | 23.4360 (56) |
| If cylinder contains dedicated solar storage |         |         |         |         |         |         |         |         |         |         |         |              |
| 23.4360                                      | 21.1680 | 23.4360 | 22.6800 | 23.4360 | 22.6800 | 23.4360 | 23.4360 | 22.6800 | 23.4360 | 22.6800 | 23.4360 | 23.4360 (57) |
| Primary loss                                 | 23.2624 | 21.0112 | 23.2624 | 22.5120 | 23.2624 | 22.5120 | 23.2624 | 23.2624 | 22.5120 | 23.2624 | 22.5120 | 23.2624 (59) |
| Combi loss                                   | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000 (61)  |

Total heat required for water heating calculated for each month

|             | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|-------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| 276.4617    | 244.3527 | 259.1135 | 226.5340 | 218.7545 | 196.1904 | 192.8881 | 201.0199 | 203.7618 | 228.3346 | 244.1878 | 273.2617 | 273.2617 (62) |
| WWHRS       | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63a)  |
| PV diverter | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000 (63b) |
| Solar input | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63c)  |
| FGHRS       | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63d)  |

Output from w/h

|  | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec            |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
| 276.4617                               | 244.3527 | 259.1135 | 226.5340 | 218.7545 | 196.1904 | 192.8881 | 201.0199 | 203.7618 | 228.3346 | 244.1878 | 273.2617 | 273.2617 (64)  |
| Total per year (kWh/year) = Sum(64)m = |          |          |          |          |          |          |          |          |          |          |          | 2764.8607 (64) |

Electric shower(s)

|  | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|--|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| 0.0000   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 (64a) |
| Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = |        |        |        |        |        |        |        |        |        |        |        | 0.0000 (64a) |

Heat gains from water heating, kWh/month

|          | Jan      | Feb      | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct      | Nov      | Dec           |
|----------|----------|----------|---------|---------|---------|---------|---------|---------|---------|----------|----------|---------------|
| 113.7550 | 100.9660 | 107.9868 | 96.4498 | 94.5674 | 86.3606 | 85.9668 | 88.6706 | 88.8781 | 97.7528 | 102.3197 | 112.6910 | 112.6910 (65) |

#### 5. Internal gains (see Table 5 and 5a)

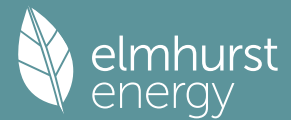
Metabolic gains (Table 5), Watts

| (66)m   | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec            |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 34.4134   | 30.5656   | 24.8577   | 18.8188   | 14.0673   | 11.8762   | 12.8327   | 16.6804   | 22.3884   | 28.4272   | 33.1787   | 35.3698 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 399.0320  | 403.1727  | 392.7382  | 370.5246  | 342.4838  | 316.1294  | 298.5230  | 294.3823  | 304.8168  | 327.0304  | 355.0712  | 381.4256 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747 (69)   |
| Pumps, fans   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 (71) |

Water heating gains (Table 5)

|                      | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|----------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| 152.8965             | 150.2471 | 145.1435 | 133.9581 | 127.1067 | 119.9452 | 115.5468 | 119.1810 | 123.4418 | 131.3881 | 142.1107 | 151.4664 | 151.4664 (72) |
| Total internal gains | 696.8444 | 694.4879 | 673.2419 | 633.8039 | 594.1602 | 558.4533 | 537.4050 | 540.7461 | 561.1494 | 597.3482 | 640.8631 | 678.7643 (73) |

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## 6. Solar gains

| [Jan]       |          |           | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W    |           |          |          |               |
|-------------|----------|-----------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|---------------|-----------|----------|----------|---------------|
| North       |          |           | 4.8500     | 10.6334                        | 0.5800                            | 0.0000                             | 0.7700                       | 23.0320 (74)  |           |          |          |               |
| East        |          |           | 0.7600     | 19.6403                        | 0.5800                            | 0.0000                             | 0.7700                       | 6.6662 (76)   |           |          |          |               |
| South       |          |           | 5.6100     | 46.7521                        | 0.5800                            | 0.0000                             | 0.7700                       | 117.1338 (78) |           |          |          |               |
| North       |          |           | 5.0400     | 10.6334                        | 0.6300                            | 0.7000                             | 0.7700                       | 16.3785 (74)  |           |          |          |               |
| South       |          |           | 1.4000     | 47.0123                        | 0.6300                            | 0.7000                             | 1.0000                       | 26.1229 (82)  |           |          |          |               |
| Solar gains | 189.3335 | 326.8103  | 462.0126   | 602.9460                       | 707.2243                          | 717.2106                           | 685.1038                     | 604.2845      | 509.9668  | 364.8702 | 227.4790 | 161.6212 (83) |
| Total gains | 886.1778 | 1021.2981 | 1135.2545  | 1236.7500                      | 1301.3845                         | 1275.6639                          | 1222.5087                    | 1145.0306     | 1071.1162 | 962.2185 | 868.3421 | 840.3855 (84) |

## 7. Mean internal temperature (heating season)

| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         | 21.0000 (85) |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |         |         |              |
|   | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
| tau   | 58.4665 | 58.7276 | 58.9911 | 60.3448 | 60.6231 | 62.0537 | 62.0537 | 62.3479 | 61.4734 | 60.6231 | 60.0692 | 59.5253      |
| alpha   | 4.8978  | 4.9152  | 4.9327  | 5.0230  | 5.0415  | 5.1369  | 5.1369  | 5.1565  | 5.0982  | 5.0415  | 5.0046  | 4.9684       |
| util living area  | 0.9707  | 0.9437  | 0.8892  | 0.7740  | 0.6111  | 0.4331  | 0.3126  | 0.3469  | 0.5519  | 0.8182  | 0.9444  | 0.9760 (86)  |
| Living  | 20.0660 | 20.2921 | 20.5641 | 20.8271 | 20.9544 | 20.9938 | 20.9991 | 20.9984 | 20.9794 | 20.8082 | 20.4086 | 20.0327      |
| Non living  | 19.1220 | 19.4047 | 19.7368 | 20.0526 | 20.1876 | 20.2387 | 20.2423 | 20.2453 | 20.2215 | 20.0419 | 19.5660 | 19.0904      |
| 24 / 16   | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0            |
| 24 / 9  | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0            |
| 16 / 9  | 28      | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 10           |
| MIT   | 20.5222 | 20.2921 | 20.5641 | 20.8271 | 20.9544 | 20.9938 | 20.9991 | 20.9984 | 20.9794 | 20.8082 | 20.4086 | 20.1680 (87) |
| Th 2  | 20.1998 | 20.2031 | 20.2064 | 20.2228 | 20.2261 | 20.2427 | 20.2427 | 20.2460 | 20.2360 | 20.2261 | 20.2195 | 20.2129 (88) |
| util rest of house  | 0.9648  | 0.9332  | 0.8701  | 0.7414  | 0.5668  | 0.3831  | 0.2591  | 0.2905  | 0.4955  | 0.7829  | 0.9322  | 0.9711 (89)  |
| MIT 2   | 19.7701 | 19.4047 | 19.7368 | 20.0526 | 20.1876 | 20.2387 | 20.2423 | 20.2453 | 20.2215 | 20.0419 | 19.5660 | 19.2927 (90) |
| Living area fraction  |         |         |         |         |         |         |         |         |         |         |         |              |
| MIT   | 20.0544 | 19.7402 | 20.0495 | 20.3454 | 20.4774 | 20.5241 | 20.5283 | 20.5300 | 20.5080 | 20.3316 | 19.8845 | 19.6235 (91) |
| Temperature adjustment  |         |         |         |         |         |         |         |         |         |         |         | 0.0000       |
| adjusted MIT  | 20.0544 | 19.7402 | 20.0495 | 20.3454 | 20.4774 | 20.5241 | 20.5283 | 20.5300 | 20.5080 | 20.3316 | 19.8845 | 19.6235 (93) |

## 8. Space heating requirement

|  | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec                        |
|--|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------------------|
| Utilisation  | 0.9636    | 0.9261    | 0.8660    | 0.7468    | 0.5815   | 0.4018   | 0.2793   | 0.3118   | 0.5159   | 0.7881   | 0.9262    | 0.9667 (94)                |
| Useful gains   | 853.8982  | 945.8529  | 983.0999  | 923.5930  | 756.7319 | 512.5533 | 341.4710 | 357.0634 | 552.6061 | 758.2807 | 804.2206  | 812.3813 (95)              |
| Ext temp.  | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000  | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000  | 7.1000    | 4.2000 (96)                |
| Heat loss rate W   | 1454.9834 | 1364.4563 | 1240.2228 | 1024.1253 | 781.7961 | 515.4883 | 341.8246 | 357.6736 | 562.8547 | 866.7774 | 1149.2001 | 1399.0925 (97)             |
| Space heating kWh  | 447.2074  | 281.3015  | 191.2994  | 72.3833   | 18.6478  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 80.7215  | 248.3852  | 436.5131 (98a)             |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |          |          |          |          |          |          |           | 1776.4592                  |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000 (98b)               |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |          |          |          |          |          |          |           | 0.0000                     |
| Space heating kWh  | 447.2074  | 281.3015  | 191.2994  | 72.3833   | 18.6478  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 80.7215  | 248.3852  | 436.5131 (98c)             |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |          |          |          |          |          |          |           | 1776.4592                  |
| Space heating per m2   |           |           |           |           |          |          |          |          |          |          |           | (98c) / (4) = 16.5838 (99) |

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

| Fraction of space heat from secondary/supplementary system (Table 11)                                |          |          |           |           |           |           |           |           |           |          |          | 0.0000 (201)    |
|--|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|-----------------|
| Fraction of space heat from main system(s)   |          |          |           |           |           |           |           |           |           |          |          | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)   |          |          |           |           |           |           |           |           |           |          |          | 273.8380 (206)  |
| Efficiency of main space heating system 2 (in %)   |          |          |           |           |           |           |           |           |           |          |          | 0.0000 (207)    |
| Efficiency of secondary/supplementary heating system, %  |          |          |           |           |           |           |           |           |           |          |          | 60.0000 (208)   |
|  | Jan      | Feb      | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct      | Nov      | Dec             |
| Space heating requirement  | 447.2074 | 281.3015 | 191.2994  | 72.3833   | 18.6478   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 80.7215  | 248.3852 | 436.5131 (98)   |
| Space heating efficiency (main heating system 1)   | 273.8380 | 273.8380 | 273.8380  | 273.8380  | 273.8380  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 273.8380 | 273.8380 | 273.8380 (210)  |
| Space heating fuel (main heating system)   | 163.3109 | 102.7255 | 69.8586   | 26.4329   | 6.8098    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 29.4778  | 90.7052  | 159.4056 (211)  |
| Space heating efficiency (main heating system 2)   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (212)    |
| Space heating fuel (main heating system 2)   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (213)    |
| Space heating fuel (secondary)   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (215)    |
| Water heating  |          |          |           |           |           |           |           |           |           |          |          |                 |
| Water heating requirement  | 276.4617 | 244.3527 | 259.1135  | 226.5340  | 218.7545  | 196.1904  | 192.8881  | 201.0199  | 203.7618  | 228.3346 | 244.1878 | 273.2617 (64)   |
| Efficiency of water heater (217)m  | 284.3490 | 284.3490 | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490 | 284.3490 | 284.3490 (216)  |
| Fuel for water heating, kWh/month  | 97.2262  | 85.9341  | 91.1252   | 79.6676   | 76.9317   | 68.9963   | 67.8350   | 70.6948   | 71.6591   | 80.3008  | 85.8761  | 96.1008 (219)   |
| Space cooling fuel requirement (221)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (221)    |
| Pumps and Fa   | 18.9800  | 17.1432  | 18.9800   | 18.3677   | 18.9800   | 18.3677   | 18.9800   | 18.9800   | 18.3677   | 18.9800  | 18.3677  | 18.9800 (231)   |
| Lighting   | 30.1218  | 24.1648  | 21.7578   | 15.9407   | 12.3130   | 10.0598   | 11.2324   | 14.6002   | 18.9643   | 24.8821  | 28.1043  | 30.9590 (232)   |
| Electricity generated by PVs (Appendix M) (negative quantity)  | -61.1968 | -84.5389 | -117.4902 | -126.5337 | -133.4149 | -123.3776 | -122.0874 | -116.2111 | -105.1403 | -92.4702 | -66.0775 | -53.0845 (233a) |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (234a)   |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (235a)   |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) |          |          |           |           |           |           |           |           |           |          |          |                 |

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|  |          |          |           |           |           |           |           |           |           |          |          |          |        |
|--|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|--------|
| (235c)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (235c) |
| Electricity generated by PVs (Appendix M) (negative quantity)  |          |          |           |           |           |           |           |           |           |          |          |          |        |
| (233b)m  | -28.3447 | -59.7936 | -116.2568 | -171.5859 | -223.4746 | -223.2536 | -221.7264 | -191.4592 | -146.4634 | -88.6194 | -39.0938 | -22.5658 | (233b) |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              |          |          |           |           |           |           |           |           |           |          |          |          |        |
| (234b)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (234b) |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  |          |          |           |           |           |           |           |           |           |          |          |          |        |
| (235b)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (235b) |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) |          |          |           |           |           |           |           |           |           |          |          |          |        |
| (235d)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (235d) |
| Annual totals kWh/year   |          |          |           |           |           |           |           |           |           |          |          |          |        |
| Space heating fuel - main system 1   |          |          |           |           |           |           |           |           |           |          |          | 648.7263 | (211)  |
| Space heating fuel - main system 2   |          |          |           |           |           |           |           |           |           |          |          | 0.0000   | (213)  |
| Space heating fuel - secondary   |          |          |           |           |           |           |           |           |           |          |          | 0.0000   | (215)  |
| Efficiency of water heater   |          |          |           |           |           |           |           |           |           |          |          | 284.3490 |        |
| Water heating fuel used  |          |          |           |           |           |           |           |           |           |          |          | 972.3475 | (219)  |
| Space cooling fuel   |          |          |           |           |           |           |           |           |           |          |          | 0.0000   | (221)  |

|   |  |  |  |  |  |  |  |  |  |  |  |  |            |        |
|---|--|--|--|--|--|--|--|--|--|--|--|--|------------|--------|
| Electricity for pumps and fans:<br>(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7125)<br>mechanical ventilation fans (SFP = 0.7125) |  |  |  |  |  |  |  |  |  |  |  |  | 223.4737   | (230a) |
| Total electricity for the above, kWh/year   |  |  |  |  |  |  |  |  |  |  |  |  | 223.4737   | (231)  |
| Electricity for lighting (calculated in Appendix L)   |  |  |  |  |  |  |  |  |  |  |  |  | 243.1003   | (232)  |
| Energy saving/generation technologies (Appendices M ,N and Q)   |  |  |  |  |  |  |  |  |  |  |  |  |            |        |
| PV generation   |  |  |  |  |  |  |  |  |  |  |  |  | -2734.2604 | (233)  |
| Wind generation   |  |  |  |  |  |  |  |  |  |  |  |  | 0.0000     | (234)  |
| Hydro-electric generation (Appendix N)  |  |  |  |  |  |  |  |  |  |  |  |  | 0.0000     | (235a) |
| Electricity generated - Micro CHP (Appendix N)  |  |  |  |  |  |  |  |  |  |  |  |  | 0.0000     | (235)  |
| Appendix Q - special features   |  |  |  |  |  |  |  |  |  |  |  |  |            |        |
| Energy saved or generated   |  |  |  |  |  |  |  |  |  |  |  |  | -0.0000    | (236)  |
| Energy used   |  |  |  |  |  |  |  |  |  |  |  |  | 0.0000     | (237)  |
| Total delivered energy for all uses   |  |  |  |  |  |  |  |  |  |  |  |  | -646.6126  | (238)  |

## 10a. Fuel costs - using Table 12 prices

|   | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |        |
|---|---------------|------------------|------------------|--------|
| Space heating - main system 1               | 648.7263      | 16.4900          | 106.9750         | (240)  |
| Total CO2 associated with community systems |               |                  | 0.0000           | (473)  |
| Water heating (other fuel)                  | 972.3475      | 16.4900          | 160.3401         | (247)  |
| Energy for instantaneous electric shower(s) | 0.0000        | 16.4900          | 0.0000           | (247a) |
| Pumps, fans and electric keep-hot           | 223.4737      | 16.4900          | 36.8508          | (249)  |
| Energy for lighting                         | 243.1003      | 16.4900          | 40.0872          | (250)  |
| Additional standing charges                 |               |                  | 0.0000           | (251)  |
| Energy saving/generation technologies       |               |                  |                  |        |
| PV Unit electricity used in dwelling        | -1201.6232    | 16.4900          | -198.1477        |        |
| PV Unit electricity exported                | -1532.6372    | 5.5900           | -85.6744         |        |
| Total                                       |               |                  | -283.8221        | (252)  |
| Total energy cost                           |               |                  | 60.4310          | (255)  |

## 11a. SAP rating - Individual heating systems

|                                  |   |         |       |
|----------------------------------|---|---------|-------|
| Energy cost deflator (Table 12): |   | 0.3600  | (256) |
| Energy cost factor (ECF)         | $[(255) \times (256)] / [(4) + 45.0] =$ | 0.1430  | (257) |
| SAP value                        |   | 97.6818 |       |
| SAP rating (Section 12)          |   | 98      | (258) |
| SAP band                         |   | A       |       |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|   | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |       |
|---|-----------------|----------------------------|-----------------------|-------|
| Space heating - main system 1               | 648.7263        | 0.1574                     | 102.1115              | (261) |
| Total CO2 associated with community systems |                 |                            | 0.0000                | (373) |
| Water heating (other fuel)                  | 972.3475        | 0.1410                     | 137.1090              | (264) |
| Space and water heating                     |                 |                            | 239.2205              | (265) |
| Pumps, fans and electric keep-hot           | 223.4737        | 0.1387                     | 30.9986               | (267) |
| Energy for lighting                         | 243.1003        | 0.1443                     | 35.0869               | (268) |
| Energy saving/generation technologies       |                 |                            |                       |       |
| PV Unit electricity used in dwelling        | -1201.6232      | 0.1353                     | -162.5886             |       |
| PV Unit electricity exported                | -1532.6372      | 0.1263                     | -193.6043             |       |
| Total                                       |                 |                            | -356.1929             | (269) |
| Total CO2, kg/year                          |                 |                            | -50.8870              | (272) |
| CO2 emissions per m2                        |                 |                            | -0.4800               | (273) |
| EI value                                    |                 |                            | 100.4483              |       |
| EI rating                                   |                 |                            | 100                   | (274) |
| EI band                                     |                 |                            | A                     |       |

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)  
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY

## 1. Overall dwelling characteristics

|  | Area (m2)    | Storey height (m) | Volume (m3)            |  |
|--|--------------|-------------------|------------------------|--|
| Ground floor   | 53.5600 (1b) | x 2.5000 (2b)     | = 133.9000 (1b) - (3b) |  |
| First floor  | 53.5600 (1c) | x 2.3000 (2c)     | = 123.1880 (1c) - (3c) |  |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 107.1200     |                   | (4)                    |  |

# Full SAP Calculation Printout



Dwelling volume

(3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 257.0880 (5)

## 2. Ventilation rate

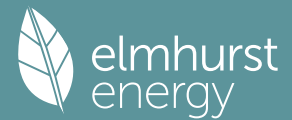
|   |   |        |        |        |        |        |        |        |        |        |        |                             |               |             |
|---|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----------------------------|---------------|-------------|
|   | m3 per hour   |        |        |        |        |        |        |        |        |        |        |                             |               |             |
| Number of open chimneys   |   |        |        |        |        |        |        |        |        |        |        | 0 * 80 =                    | 0.0000 (6a)   |             |
| Number of open flues  |   |        |        |        |        |        |        |        |        |        |        | 1 * 20 =                    | 20.0000 (6b)  |             |
| Number of chimneys / flues attached to closed fire  |   |        |        |        |        |        |        |        |        |        |        | 0 * 10 =                    | 0.0000 (6c)   |             |
| Number of flues attached to solid fuel boiler   |   |        |        |        |        |        |        |        |        |        |        | 0 * 20 =                    | 0.0000 (6d)   |             |
| Number of flues attached to other heater  |   |        |        |        |        |        |        |        |        |        |        | 0 * 35 =                    | 0.0000 (6e)   |             |
| Number of blocked chimneys  |   |        |        |        |        |        |        |        |        |        |        | 0 * 20 =                    | 0.0000 (6f)   |             |
| Number of intermittent extract fans   |   |        |        |        |        |        |        |        |        |        |        | 0 * 10 =                    | 0.0000 (7a)   |             |
| Number of passive vents   |   |        |        |        |        |        |        |        |        |        |        | 0 * 10 =                    | 0.0000 (7b)   |             |
| Number of flueless gas fires  |   |        |        |        |        |        |        |        |        |        |        | 0 * 40 =                    | 0.0000 (7c)   |             |
|   |   |        |        |        |        |        |        |        |        |        |        | Air changes per hour        |               |             |
| Infiltration due to chimneys, flues and fans  | = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = |        |        |        |        |        |        |        |        |        |        | 20.0000 / (5) =             | 0.0778 (8)    |             |
| Pressure test   |   |        |        |        |        |        |        |        |        |        |        | Yes                         |               |             |
| Pressure Test Method  |   |        |        |        |        |        |        |        |        |        |        | Blower Door                 |               |             |
| Measured/design AP50  |   |        |        |        |        |        |        |        |        |        |        | 3.0000 (17)                 |               |             |
| Infiltration rate   |   |        |        |        |        |        |        |        |        |        |        | 0.2278 (18)                 |               |             |
| Number of sides sheltered   |   |        |        |        |        |        |        |        |        |        |        | 2 (19)                      |               |             |
| Shelter factor  |   |        |        |        |        |        |        |        |        |        |        | (20) = 1 - [0.075 x (19)] = |               | 0.8500 (20) |
| Infiltration rate adjusted to include shelter factor  |   |        |        |        |        |        |        |        |        |        |        | (21) = (18) x (20) =        |               | 0.1936 (21) |
| Wind speed  | Jan   | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec                         |               |             |
| Wind factor   | 6.3000  | 6.0000 | 5.8000 | 5.1000 | 5.1000 | 4.6000 | 4.6000 | 4.5000 | 4.9000 | 5.7000 | 5.9000 | 6.3000                      | (22)          |             |
| Adj infilt rate   | 1.5750  | 1.5000 | 1.4500 | 1.2750 | 1.2750 | 1.1500 | 1.1500 | 1.1250 | 1.2250 | 1.4250 | 1.4750 | 1.5750                      | (22a)         |             |
| Balanced mechanical ventilation with heat recovery  | 0.3050  | 0.2904 | 0.2808 | 0.2469 | 0.2469 | 0.2227 | 0.2227 | 0.2178 | 0.2372 | 0.2759 | 0.2856 | 0.3050                      | (22b)         |             |
| If mechanical ventilation   |   |        |        |        |        |        |        |        |        |        |        |                             | 0.5000 (23a)  |             |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |   |        |        |        |        |        |        |        |        |        |        |                             | 0.5000 (23b)  |             |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |   |        |        |        |        |        |        |        |        |        |        |                             | 84.6000 (23c) |             |
| Effective ac  | 0.3820  | 0.3674 | 0.3578 | 0.3239 | 0.3239 | 0.2997 | 0.2997 | 0.2948 | 0.3142 | 0.3529 | 0.3626 | 0.3820                      | (25)          |             |

## 3. Heat losses and heat loss parameter

| Element   | Gross m2 | Openings m2 | NetArea m2 | U-value W/m2K | A x U W/K            | K-value kJ/m2K | A x K kJ/K |         |         |         |         |         |                                      |                 |
|---|----------|-------------|------------|---------------|----------------------|----------------|------------|---------|---------|---------|---------|---------|--------------------------------------|-----------------|
| Front door  |          |             | 2.1200     | 1.5000        | 3.1800               |                |            | (26)    |         |         |         |         |                                      |                 |
| Utility Door  |          |             | 2.1200     | 1.2000        | 2.5440               |                |            | (26a)   |         |         |         |         |                                      |                 |
| Window (Uw = 0.80)  |          |             | 11.2200    | 0.7752        | 8.6977               |                |            | (27)    |         |         |         |         |                                      |                 |
| French Door (Uw = 1.00)   |          |             | 5.0400     | 0.9615        | 4.8462               |                |            | (27)    |         |         |         |         |                                      |                 |
| Front   |          |             | 1.4000     | 1.0536        | 1.4751               |                |            | (27a)   |         |         |         |         |                                      |                 |
| Ground Floor  |          |             | 53.5600    | 0.1200        | 6.4272               | 75.0000        | 4017.0000  | (28a)   |         |         |         |         |                                      |                 |
| External Wall 1   | 128.6600 | 20.5000     | 108.1600   | 0.1500        | 16.2240              | 110.0000       | 11897.6000 | (29a)   |         |         |         |         |                                      |                 |
| Dormer Cheek  | 14.6200  |             | 14.6200    | 0.2100        | 3.0702               | 9.0000         | 131.5800   | (29a)   |         |         |         |         |                                      |                 |
| Cold Roof   | 32.1100  |             | 32.1100    | 0.0900        | 2.8899               | 9.0000         | 288.9900   | (30)    |         |         |         |         |                                      |                 |
| Sloping Roof  | 15.7200  | 1.4000      | 14.3200    | 0.1300        | 1.8616               | 9.0000         | 128.8800   | (30)    |         |         |         |         |                                      |                 |
| Dormer Roof   | 10.9200  |             | 10.9200    | 0.1000        | 1.0920               | 9.0000         | 98.2800    | (30)    |         |         |         |         |                                      |                 |
| Total net area of external elements Aum(A, m2)                      |          |             | 255.5900   |               |                      |                |            | (31)    |         |         |         |         |                                      |                 |
| Fabric heat loss, W/K = Sum (A x U)                                 |          |             |            |               | (26)...(30) + (32) = | 52.3078        |            | (33)    |         |         |         |         |                                      |                 |
| GF  |          |             | 68.1300    |               |                      | 9.0000         | 613.1700   | (32c)   |         |         |         |         |                                      |                 |
| FF  |          |             | 90.7800    |               |                      | 9.0000         | 817.0200   | (32c)   |         |         |         |         |                                      |                 |
| Internal Floor 1  |          |             | 53.5600    |               |                      | 18.0000        | 964.0800   | (32d)   |         |         |         |         |                                      |                 |
| Internal Ceiling 1  |          |             | 53.5600    |               |                      | 9.0000         | 482.0400   | (32e)   |         |         |         |         |                                      |                 |
| Heat capacity Cm = Sum(A x k)                                       |          |             |            |               |                      |                |            |         |         |         |         |         | (28)...(30) + (32) + (32a)...(32e) = | 19438.6400 (34) |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |          |             |            |               |                      |                |            |         |         |         |         |         |                                      | 181.4660 (35)   |
| List of Thermal Bridges   |          |             |            |               |                      |                |            |         |         |         |         |         |                                      |                 |
| K1 Element  |          |             | Length     | Psi-value     | Total                |                |            |         |         |         |         |         |                                      |                 |
| E1 Steel lintel with perforated steel base plate                    |          |             | 13.7700    | 0.0500        | 0.6885               |                |            |         |         |         |         |         |                                      |                 |
| E3 Sill   |          |             | 9.3500     | 0.0210        | 0.1963               |                |            |         |         |         |         |         |                                      |                 |
| E4 Jamb   |          |             | 36.0000    | 0.0160        | 0.5760               |                |            |         |         |         |         |         |                                      |                 |
| E5 Ground floor (normal)  |          |             | 29.8500    | 0.1120        | 3.3432               |                |            |         |         |         |         |         |                                      |                 |
| E6 Intermediate floor within a dwelling                             |          |             | 29.8500    | 0.0020        | 0.0597               |                |            |         |         |         |         |         |                                      |                 |
| E16 Corner (normal)   |          |             | 17.2000    | 0.0510        | 0.8772               |                |            |         |         |         |         |         |                                      |                 |
| R1 Head of roof window  |          |             | 1.2700     | 0.2400        | 0.3048               |                |            |         |         |         |         |         |                                      |                 |
| R2 Sill of roof window  |          |             | 1.2700     | 0.2400        | 0.3048               |                |            |         |         |         |         |         |                                      |                 |
| R3 Jamb of roof window  |          |             | 2.2000     | 0.2400        | 0.5280               |                |            |         |         |         |         |         |                                      |                 |
| E10 Eaves (insulation at ceiling level)                             |          |             | 9.6500     | 0.0630        | 0.6079               |                |            |         |         |         |         |         |                                      |                 |
| E11 Eaves (insulation at rafter level)                              |          |             | 8.5100     | 0.0170        | 0.1447               |                |            |         |         |         |         |         |                                      |                 |
| E12 Gable (insulation at ceiling level)                             |          |             | 16.2900    | 0.0980        | 1.5964               |                |            |         |         |         |         |         |                                      |                 |
| E13 Gable (insulation at rafter level)                              |          |             | 4.8300     | 0.0510        | 0.2463               |                |            |         |         |         |         |         |                                      |                 |
| R6 Flat ceiling   |          |             | 8.8300     | 0.0600        | 0.5298               |                |            |         |         |         |         |         |                                      |                 |
| R7 Flat ceiling (inverted)  |          |             | 18.6800    | 0.0600        | 1.1208               |                |            |         |         |         |         |         |                                      |                 |
| R9 Roof to wall (flat ceiling)                                      |          |             | 9.0300     | 0.1600        | 1.4448               |                |            |         |         |         |         |         |                                      |                 |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |          |             |            |               |                      |                |            |         |         |         |         |         | 12.5693 (36)                         |                 |
| Point Thermal bridges   |          |             |            |               |                      |                |            |         |         |         |         |         | (36a) =                              | 0.0000          |
| Total fabric heat loss  |          |             |            |               |                      |                |            |         |         |         |         |         | (33) + (36) + (36a) =                | 64.8771 (37)    |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |             |            |               |                      |                |            |         |         |         |         |         |                                      |                 |
| (38)m   | Jan      | Feb         | Mar        | Apr           | May                  | Jun            | Jul        | Aug     | Sep     | Oct     | Nov     | Dec     |                                      |                 |
| Heat transfer coeff   | 32.4051  | 31.1731     | 30.3517    | 27.4770       | 27.4770              | 25.4236        | 25.4236    | 25.0130 | 26.6557 | 29.9410 | 30.7624 | 32.4051 | (38)                                 |                 |
| Average = Sum(39)m / 12 =   | 97.2822  | 96.0502     | 95.2289    | 92.3541       | 92.3541              | 90.3008        | 90.3008    | 89.8901 | 91.5328 | 94.8182 | 95.6395 | 97.2822 | (39)                                 |                 |
|   |          |             |            |               |                      |                |            |         |         |         |         |         | 93.5862                              |                 |
| HLP   | Jan      | Feb         | Mar        | Apr           | May                  | Jun            | Jul        | Aug     | Sep     | Oct     | Nov     | Dec     |                                      |                 |
| HLP (average)   | 0.9082   | 0.8967      | 0.8890     | 0.8622        | 0.8622               | 0.8430         | 0.8430     | 0.8392  | 0.8545  | 0.8852  | 0.8928  | 0.9082  | (40)                                 |                 |
| Days in mont  | 31       | 28          | 31         | 30            | 31                   | 30             | 31         | 31      | 30      | 31      | 30      | 31      |                                      |                 |

## 4. Water heating energy requirements (kWh/year)

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|  |          |          |          |          |          |          |          |          |          |          |          |                              |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|------------------------------|
| Assumed occupancy  |          |          |          |          |          |          |          |          |          |          |          | 2.7964 (42)                  |
| Hot water usage for mixer showers  |          |          |          |          |          |          |          |          |          |          |          | 70.8336 (42a)                |
| Hot water usage for baths  |          |          |          |          |          |          |          |          |          |          |          | 30.5974 (42b)                |
| Hot water usage for other uses   |          |          |          |          |          |          |          |          |          |          |          | 43.2678 (42c)                |
| Average daily hot water use (litres/day)                                       |          |          |          |          |          |          |          |          |          |          |          | 133.3566 (43)                |
| Daily hot water use  | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec                          |
| Energy content (annual)  | 145.0750 | 141.9771 | 138.2045 | 132.4679 | 127.8094 | 122.8012 | 120.8766 | 124.6329 | 128.5945 | 133.8523 | 139.6772 | 144.6988 (44)                |
| Energy content (annual)  | 229.7633 | 202.1735 | 212.4151 | 181.3420 | 172.0561 | 150.9984 | 146.1897 | 154.3215 | 158.5698 | 181.6362 | 198.9958 | 226.5633 (45)                |
| Distribution loss (46)m = 0.15 x (45)m   |          |          |          |          |          |          |          |          |          |          |          | Total = Sum(45)m = 2215.0247 |
| Water storage loss:  |          |          |          |          |          |          |          |          |          |          |          | 34.4645 (46)                 |
| Store volume   |          |          |          |          |          |          |          |          |          |          |          | 250.0000 (47)                |
| a) If manufacturer declared loss factor is known (kWh/day):                    |          |          |          |          |          |          |          |          |          |          |          | 1.4000 (48)                  |
| Temperature factor from Table 2b   |          |          |          |          |          |          |          |          |          |          |          | 0.5400 (49)                  |
| Enter (49) or (54) in (55)   |          |          |          |          |          |          |          |          |          |          |          | 0.7560 (55)                  |
| Total storage loss   |          |          |          |          |          |          |          |          |          |          |          | 23.4360 (56)                 |
| If cylinder contains dedicated solar storage                                   |          |          |          |          |          |          |          |          |          |          |          | 23.4360 (57)                 |
| Primary loss   |          |          |          |          |          |          |          |          |          |          |          | 23.2624 (59)                 |
| Combi loss   |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (61)                  |
| Total heat required for water heating calculated for each month                |          |          |          |          |          |          |          |          |          |          |          | 276.4617 (62)                |
| WWHRS  |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63a)                 |
| PV diverter  |          |          |          |          |          |          |          |          |          |          |          | -0.0000 (63b)                |
| Solar input  |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63c)                 |
| FGHRS  |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63d)                 |
| Output from w/h  |          |          |          |          |          |          |          |          |          |          |          | 276.4617 (64)                |
| Electric shower(s)   |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (64a)                 |
| Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (64a)                 |
| Heat gains from water heating, kWh/month                                       |          |          |          |          |          |          |          |          |          |          |          | 113.7550 (65)                |

## 5. Internal gains (see Table 5 and 5a)

|   |          |          |          |          |          |          |          |          |          |          |          |                |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
| Metabolic gains (Table 5), Watts  | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec            |
| (66)m   | 167.7833 | 167.7833 | 167.7833 | 167.7833 | 167.7833 | 167.7833 | 167.7833 | 167.7833 | 167.7833 | 167.7833 | 167.7833 | 167.7833 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |          |          |          |          |          |          |          |          |          |          |          | 34.4134 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |          |          |          |          |          |          |          |          |          |          |          | 399.0320 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |          |          |          |          |          |          |          |          |          |          |          | 54.5747 (69)   |
| Pumps, fans   |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 |          |          |          |          |          |          |          |          |          |          |          | -111.8555 (71) |
| Water heating gains (Table 5)   |          |          |          |          |          |          |          |          |          |          |          | 152.8965 (72)  |
| Total internal gains  |          |          |          |          |          |          |          |          |          |          |          | 696.8444 (73)  |

## 6. Solar gains

| [Jan]       | Area m2  | Solar flux Table 6a W/m2 | g Specific data or Table 6b | FF Specific data or Table 6c | Access factor Table 6d | Gains W       |           |           |           |           |          |               |
|-------------|----------|--------------------------|-----------------------------|------------------------------|------------------------|---------------|-----------|-----------|-----------|-----------|----------|---------------|
| North       | 4.8500   | 14.1804                  | 0.5800                      | 0.0000                       | 0.7700                 | 30.7149 (74)  |           |           |           |           |          |               |
| East        | 0.7600   | 26.5524                  | 0.5800                      | 0.0000                       | 0.7700                 | 9.0123 (76)   |           |           |           |           |          |               |
| South       | 5.6100   | 59.0235                  | 0.5800                      | 0.0000                       | 0.7700                 | 147.8791 (78) |           |           |           |           |          |               |
| North       | 5.0400   | 14.1804                  | 0.6300                      | 0.7000                       | 0.7700                 | 21.8419 (74)  |           |           |           |           |          |               |
| South       | 1.4000   | 61.2906                  | 0.6300                      | 0.7000                       | 1.0000                 | 34.0567 (82)  |           |           |           |           |          |               |
| Solar gains | 243.5049 | 361.5405                 | 505.4843                    | 682.9859                     | 758.0677               | 834.3107      | 720.0570  | 680.9105  | 583.5795  | 414.5551  | 282.0103 | 207.1747 (83) |
| Total gains | 940.3493 | 1056.0284                | 1178.7261                   | 1316.7899                    | 1352.2279              | 1392.7640     | 1257.4619 | 1221.6566 | 1144.7289 | 1011.9034 | 922.8734 | 885.9391 (84) |

## 7. Mean internal temperature (heating season)

|   |         |         |         |         |         |         |         |         |         |         |         |                                       |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         | 21.0000 (85)                          |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |         |         | 0.9437 (86)                           |
| tau   | 55.5047 | 56.2167 | 56.7015 | 58.4665 | 58.4665 | 59.7960 | 59.7960 | 60.0692 | 58.9911 | 56.9471 | 56.4581 | 55.5047                               |
| alpha   | 4.7003  | 4.7478  | 4.7801  | 4.8978  | 4.8978  | 4.9864  | 4.9864  | 5.0046  | 4.9327  | 4.7965  | 4.7639  | 4.7003                                |
| util living area  | 0.9437  | 0.9130  | 0.8466  | 0.7220  | 0.5859  | 0.4119  | 0.3436  | 0.3302  | 0.4878  | 0.7394  | 0.8904  | 0.9493 (86)                           |
| Living  | 20.3049 | 20.4573 | 20.6735 | 20.8728 | 20.9593 | 20.9942 | 20.9981 | 20.9985 | 20.9875 | 20.8826 | 20.6220 | 20.2948                               |
| Non living  | 19.3907 | 19.5816 | 19.8403 | 20.0797 | 20.1664 | 20.2125 | 20.2153 | 20.2189 | 20.1984 | 20.0786 | 19.7862 | 19.3798                               |
| 24 / 16   | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                                     |
| 24 / 9  | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                                     |
| 16 / 9  | 28      | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 10                                    |
| MIT   | 20.6444 | 20.4573 | 20.6735 | 20.8728 | 20.9593 | 20.9942 | 20.9981 | 20.9985 | 20.9875 | 20.8826 | 20.6220 | 20.3935 (87)                          |
| Th 2  | 20.1606 | 20.1703 | 20.1769 | 20.1998 | 20.1998 | 20.2162 | 20.2162 | 20.2195 | 20.2064 | 20.1801 | 20.1736 | 20.1606 (88)                          |
| util rest of house  | 0.9316  | 0.8960  | 0.8202  | 0.6845  | 0.5392  | 0.3626  | 0.2880  | 0.2734  | 0.4283  | 0.6903  | 0.8654  | 0.9378 (89)                           |
| MIT 2   | 19.8536 | 19.5816 | 19.8403 | 20.0797 | 20.1664 | 20.2125 | 20.2153 | 20.2189 | 20.1984 | 20.0786 | 19.7862 | 19.5205 (90)                          |
| Living area fraction  |         |         |         |         |         |         |         |         |         |         |         | FLA = Living area / (4) = 0.3780 (91) |
| MIT   | 20.1526 | 19.9126 | 20.1552 | 20.3795 | 20.4661 | 20.5080 | 20.5112 | 20.5136 | 20.4967 | 20.3825 | 20.1021 | 19.8505 (92)                          |
| Temperature adjustment  |         |         |         |         |         |         |         |         |         |         |         | 0.0000                                |
| adjusted MIT  | 20.1526 | 19.9126 | 20.1552 | 20.3795 | 20.4661 | 20.5080 | 20.5112 | 20.5136 | 20.4967 | 20.3825 | 20.1021 | 19.8505 (93)                          |



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## 8. Space heating requirement

|  | Jan       | Feb       | Mar       | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct           | Nov       | Dec       |       |
|--|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|---------------|-----------|-----------|-------|
| Utilisation  | 0.9314    | 0.8901    | 0.8194    | 0.6932   | 0.5550   | 0.3811   | 0.3090   | 0.2949   | 0.4503   | 0.7030        | 0.8630    | 0.9328    | (94)  |
| Useful gains   | 875.8812  | 939.9614  | 965.8533  | 912.8219 | 750.4728 | 530.7366 | 388.5255 | 360.2120 | 515.5059 | 711.4123      | 796.4355  | 826.4314  | (95)  |
| Ext temp.  | 6.6000    | 6.8000    | 8.0000    | 9.7000   | 12.1000  | 14.6000  | 16.2000  | 16.5000  | 14.8000  | 12.2000       | 9.5000    | 7.0000    | (96)  |
| Heat loss rate W   | 1318.4228 | 1259.4678 | 1157.5292 | 986.2926 | 772.6476 | 533.4953 | 389.3029 | 360.7803 | 521.4317 | 775.8508      | 1013.9841 | 1250.1242 | (97)  |
| Space heating kWh  | 329.2509  | 214.7083  | 142.6069  | 52.8989  | 16.4980  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 47.9422       | 156.6350  | 315.2275  | (98a) |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |          |          |          |          |          |          |               |           | 1275.7677 |       |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000        | 0.0000    | 0.0000    | (98b) |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |          |          |          |          |          |          |               |           | 0.0000    |       |
| Space heating kWh  | 329.2509  | 214.7083  | 142.6069  | 52.8989  | 16.4980  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 47.9422       | 156.6350  | 315.2275  | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |          |          |          |          |          |          |               |           | 1275.7677 |       |
| Space heating per m2   |           |           |           |          |          |          |          |          |          | (98c) / (4) = |           | 11.9097   | (99)  |

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

|  |          |          |           |           |           |           |           |           |           |           |          |          |            |        |
|--|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|------------|--------|
| Fraction of space heat from secondary/supplementary system (Table 11)  |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000     | (201)  |
| Fraction of space heat from main system(s)   |          |          |           |           |           |           |           |           |           |           |          |          | 1.0000     | (202)  |
| Efficiency of main space heating system 1 (in %)   |          |          |           |           |           |           |           |           |           |           |          |          | 273.4178   | (206)  |
| Efficiency of main space heating system 2 (in %)   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000     | (207)  |
| Efficiency of secondary/supplementary heating system, %  |          |          |           |           |           |           |           |           |           |           |          |          | 60.0000    | (208)  |
|  | Jan      | Feb      | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov      | Dec      |            |        |
| Space heating requirement  | 329.2509 | 214.7083 | 142.6069  | 52.8989   | 16.4980   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 47.9422   | 156.6350 | 315.2275 | (98)       |        |
| Space heating efficiency (main heating system 1)   | 273.4178 | 273.4178 | 273.4178  | 273.4178  | 273.4178  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 273.4178  | 273.4178 | 273.4178 | (210)      |        |
| Space heating fuel (main heating system)   | 120.4204 | 78.5276  | 52.1571   | 19.3473   | 6.0340    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 17.5344   | 57.2878  | 115.2915 | (211)      |        |
| Space heating efficiency (main heating system 2)   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (212)      |        |
| Space heating fuel (main heating system 2)   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (213)      |        |
| Space heating fuel (secondary)   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (215)      |        |
| Water heating  |          |          |           |           |           |           |           |           |           |           |          |          |            |        |
| Water heating requirement  | 276.4617 | 244.3527 | 259.1135  | 226.5340  | 218.7545  | 196.1904  | 192.8881  | 201.0199  | 203.7618  | 228.3346  | 244.1878 | 273.2617 | (64)       |        |
| Efficiency of water heater (217)m  | 283.6494 | 283.6494 | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494 | 283.6494 | (216)      |        |
| Fuel for water heating, kWh/month  | 97.4660  | 86.1460  | 91.3499   | 79.8641   | 77.1214   | 69.1665   | 68.0023   | 70.8692   | 71.8358   | 80.4989   | 86.0879  | 96.3378  | (219)      |        |
| Space cooling fuel requirement (221)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (221)      |        |
| Pumps and Fa   | 18.9800  | 17.1432  | 18.9800   | 18.3677   | 18.9800   | 18.3677   | 18.9800   | 18.9800   | 18.3677   | 18.9800   | 18.3677  | 18.9800  | (231)      |        |
| Lighting   | 30.1218  | 24.1648  | 21.7578   | 15.9407   | 12.3130   | 10.0598   | 11.2324   | 14.6002   | 18.9643   | 24.8821   | 28.1043  | 30.9590  | (232)      |        |
| Electricity generated by PVs (Appendix M) (negative quantity) (233a)m  | -74.2945 | -90.3908 | -123.2899 | -134.2640 | -137.4238 | -131.6439 | -124.5117 | -122.9169 | -113.2218 | -99.9545  | -76.9097 | -64.5519 | (233a)     |        |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m                              | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (234a)     |        |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m                  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (235a)     |        |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (235c)     |        |
| Electricity generated by PVs (Appendix M) (negative quantity) (233b)m  | -42.4419 | -71.1253 | -133.8851 | -202.5860 | -242.3430 | -268.1645 | -233.9382 | -222.0754 | -175.3705 | -107.7942 | -55.2008 | -33.7758 | (233b)     |        |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m                              | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (234b)     |        |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m                  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (235b)     |        |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (235d)     |        |
| Annual totals kWh/year   |          |          |           |           |           |           |           |           |           |           |          |          |            |        |
| Space heating fuel - main system 1   |          |          |           |           |           |           |           |           |           |           |          |          | 466.6001   | (211)  |
| Space heating fuel - main system 2   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000     | (213)  |
| Space heating fuel - secondary   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000     | (215)  |
| Efficiency of water heater   |          |          |           |           |           |           |           |           |           |           |          |          | 283.6494   |        |
| Water heating fuel used  |          |          |           |           |           |           |           |           |           |           |          |          | 974.7458   | (219)  |
| Space cooling fuel   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000     | (221)  |
| Electricity for pumps and fans:  |          |          |           |           |           |           |           |           |           |           |          |          |            |        |
| (BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7125)                                   |          |          |           |           |           |           |           |           |           |           |          |          |            |        |
| mechanical ventilation fans (SFP = 0.7125)   |          |          |           |           |           |           |           |           |           |           |          |          | 223.4737   | (230a) |
| Total electricity for the above, kWh/year  |          |          |           |           |           |           |           |           |           |           |          |          | 223.4737   | (231)  |
| Electricity for lighting (calculated in Appendix L)  |          |          |           |           |           |           |           |           |           |           |          |          | 243.1003   | (232)  |
| Energy saving/generation technologies (Appendices M ,N and Q)  |          |          |           |           |           |           |           |           |           |           |          |          |            |        |
| PV generation  |          |          |           |           |           |           |           |           |           |           |          |          | -3082.0742 | (233)  |
| Wind generation  |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000     | (234)  |
| Hydro-electric generation (Appendix N)   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000     | (235a) |
| Electricity generated - Micro CHP (Appendix N)   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000     | (235)  |
| Appendix Q - special features  |          |          |           |           |           |           |           |           |           |           |          |          |            |        |
| Energy saved or generated  |          |          |           |           |           |           |           |           |           |           |          |          | -0.0000    | (236)  |
| Energy used  |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000     | (237)  |
| Total delivered energy for all uses  |          |          |           |           |           |           |           |           |           |           |          |          | -1174.1543 | (238)  |

## 10a. Fuel costs - using BEDF prices (533)

|   | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |        |
|---|---------------|------------------|------------------|--------|
| Space heating - main system 1               | 466.6001      | 21.5100          | 100.3657         | (240)  |
| Total CO2 associated with community systems |               |                  | 0.0000           | (473)  |
| Water heating (other fuel)                  | 974.7458      | 21.5100          | 209.6678         | (247)  |
| Energy for instantaneous electric shower(s) | 0.0000        | 21.5100          | 0.0000           | (247a) |
| Pumps, fans and electric keep-hot           | 223.4737      | 21.5100          | 48.0692          | (249)  |
| Energy for lighting                         | 243.1003      | 21.5100          | 52.2909          | (250)  |

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|                                       |            |         |                 |
|---------------------------------------|------------|---------|-----------------|
| Additional standing charges           |            |         | 0.0000 (251)    |
| Energy saving/generation technologies |            |         |                 |
| PV Unit electricity used in dwelling  | -1293.3736 | 21.5100 | -278.2047       |
| PV Unit electricity exported          | -1788.7007 | 5.5900  | -99.9884        |
| Total                                 |            |         | -378.1930 (252) |
| Total energy cost                     |            |         | 32.2006 (255)   |

-----  
 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP  
 -----

|   | Energy<br>kWh/year | Emission factor<br>kg CO2/kWh | Emissions<br>kg CO2/year |
|---|--------------------|-------------------------------|--------------------------|
| Space heating - main system 1               | 466.6001           | 0.1577                        | 73.5638 (261)            |
| Total CO2 associated with community systems |                    |                               | 0.0000 (373)             |
| Water heating (other fuel)                  | 974.7458           | 0.1410                        | 137.4472 (264)           |
| Space and water heating                     |                    |                               | 211.0110 (265)           |
| Pumps, fans and electric keep-hot           | 223.4737           | 0.1387                        | 30.9986 (267)            |
| Energy for lighting                         | 243.1003           | 0.1443                        | 35.0869 (268)            |
| Energy saving/generation technologies       |                    |                               |                          |
| PV Unit electricity used in dwelling        | -1293.3736         | 0.1358                        | -175.7026                |
| PV Unit electricity exported                | -1788.7007         | 0.1276                        | -228.2701                |
| Total                                       |                    |                               | -403.9727 (269)          |
| Total CO2, kg/year                          |                    |                               | -126.8762 (272)          |

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

|   | Energy<br>kWh/year | Primary energy factor<br>kg CO2/kWh | Primary energy<br>kWh/year |
|---|--------------------|-------------------------------------|----------------------------|
| Space heating - main system 1               | 466.6001           | 1.5836                              | 738.9180 (275)             |
| Total CO2 associated with community systems |                    |                                     | 0.0000 (473)               |
| Water heating (other fuel)                  | 974.7458           | 1.5214                              | 1482.9809 (278)            |
| Space and water heating                     |                    |                                     | 2221.8989 (279)            |
| Pumps, fans and electric keep-hot           | 223.4737           | 1.5128                              | 338.0711 (281)             |
| Energy for lighting                         | 243.1003           | 1.5338                              | 372.8753 (282)             |
| Energy saving/generation technologies       |                    |                                     |                            |
| PV Unit electricity used in dwelling        | -1293.3736         | 1.5021                              | -1942.8027                 |
| PV Unit electricity exported                | -1788.7007         | 0.4685                              | -838.0799                  |
| Total                                       |                    |                                     | -2780.8827 (283)           |
| Total Primary energy kWh/year               |                    |                                     | 151.9626 (286)             |

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 SAP 10 EPC IMPROVEMENTS  
 -----

00001

Current energy efficiency rating: A 98  
 Current environmental impact rating: A 100

|   |            |             |                        |
|---|------------|-------------|------------------------|
| N Solar water heating                                   |            |             | SAP increase too small |
| U Solar photovoltaic panels                             |            |             | Already installed      |
| V2 Wind turbine   |            |             | Recommended            |
| Recommended measures:                                   | SAP change | Cost change | CO2 change             |
| V2 Wind turbine   | + 18.1     | -£ 598      | -496 kg (390.9%)       |
| Measures omitted - SAP change or cost saving too small: |            |             |                        |
| N Solar water heating                                   | + 0.9      | -£ 39       | -26 kg (20.2%)         |

| Recommended measures                   | Typical annual savings | Energy efficiency impact     | Environmental impact |
|--|------------------------|------------------------------|----------------------|
| Wind turbine                           | £598                   | 4.63 kg/m <sup>2</sup>       | A 116 A 105          |
| <b>Total Savings</b>                   | <b>£598</b>            | <b>4.63 kg/m<sup>2</sup></b> |                      |
| Potential energy efficiency rating:    |                        |                              | A 116                |
| Potential environmental impact rating: |                        |                              | A 105                |

Fuel prices for cost data on this page from database revision number 533 TEST (30 Nov 2023)  
 Recommendation texts revision number 6.1 (11 Jun 2019)

Typical heating and lighting costs of this home (per year, South West England):

|                                  | Current                | Potential              | Saving                |
|----------------------------------|------------------------|------------------------|-----------------------|
| Electricity                      | £410                   | £410                   | £0                    |
| Space heating                    | £148                   | £148                   | £0                    |
| Water heating                    | £210                   | £210                   | £0                    |
| Lighting                         | £52                    | £52                    | £0                    |
| Generated (PV)                   | -£378                  | -£378                  | £0                    |
| Generated (wind)                 | -£0                    | -£598                  | £598                  |
| Total cost of fuels              | £32                    | -£566                  | £598                  |
| Total cost of uses               | £32                    | -£566                  | £598                  |
| Delivered energy                 | -11 kWh/m <sup>2</sup> | -44 kWh/m <sup>2</sup> | 33 kWh/m <sup>2</sup> |
| Carbon dioxide emissions         | -0.1 tonnes            | -0.6 tonnes            | 0.5 tonnes            |
| CO2 emissions per m <sup>2</sup> | -1 kg/m <sup>2</sup>   | -6 kg/m <sup>2</sup>   | 5 kg/m <sup>2</sup>   |
| Primary energy                   | 1 kWh/m <sup>2</sup>   | -39 kWh/m <sup>2</sup> | 40 kWh/m <sup>2</sup> |

# Full SAP Calculation Printout



## CALCULATION OF ENERGY RATING FOR IMPROVED DWELLING

### 1. Overall dwelling characteristics

|  | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--|---------------------------|---------------------------------|-----------------------------|
| Ground floor   | 53.5600 (1b)              | x 2.5000 (2b)                   | = 133.9000 (1b) - (3b)      |
| First floor  | 53.5600 (1c)              | x 2.3000 (2c)                   | = 123.1880 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 107.1200                  |                                 | (4)                         |
| Dwelling volume  |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 257.0880 (5)              |

### 2. Ventilation rate

|   | m <sup>3</sup> per hour     |        |        |        |        |        |        |        |        |        |        |               |
|---|-----------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------------|
| Number of open chimneys   | 0 * 80 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6a)   |
| Number of open flues  | 1 * 20 =                    |        |        |        |        |        |        |        |        |        |        | 20.0000 (6b)  |
| Number of chimneys / flues attached to closed fire  | 0 * 10 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6c)   |
| Number of flues attached to solid fuel boiler   | 0 * 20 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6d)   |
| Number of flues attached to other heater  | 0 * 35 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6e)   |
| Number of blocked chimneys  | 0 * 20 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6f)   |
| Number of intermittent extract fans   | 0 * 10 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (7a)   |
| Number of passive vents   | 0 * 10 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (7b)   |
| Number of flueless gas fires  | 0 * 40 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (7c)   |
| Air changes per hour  |                             |        |        |        |        |        |        |        |        |        |        |               |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =      | 20.0000 / (5) =             |        |        |        |        |        |        |        |        |        |        | 0.0778 (8)    |
| Pressure test   | Yes                         |        |        |        |        |        |        |        |        |        |        |               |
| Pressure Test Method  | Blower Door                 |        |        |        |        |        |        |        |        |        |        |               |
| Measured/design AP50  |                             |        |        |        |        |        |        |        |        |        |        | 3.0000 (17)   |
| Infiltration rate   |                             |        |        |        |        |        |        |        |        |        |        | 0.2278 (18)   |
| Number of sides sheltered   |                             |        |        |        |        |        |        |        |        |        |        | 2 (19)        |
| Shelter factor  | (20) = 1 - [0.075 x (19)] = |        |        |        |        |        |        |        |        |        |        | 0.8500 (20)   |
| Infiltration rate adjusted to include shelter factor  | (21) = (18) x (20) =        |        |        |        |        |        |        |        |        |        |        | 0.1936 (21)   |
| Wind speed  | Jan                         | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec           |
| Wind factor   | 5.1000                      | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)   |
| Adj infilt rate   | 1.2750                      | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a)  |
| Balanced mechanical ventilation with heat recovery  | 0.2469                      | 0.2420 | 0.2372 | 0.2130 | 0.2081 | 0.1839 | 0.1839 | 0.1791 | 0.1936 | 0.2081 | 0.2178 | 0.2275 (22b)  |
| If mechanical ventilation   |                             |        |        |        |        |        |        |        |        |        |        | 0.5000 (23a)  |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |                             |        |        |        |        |        |        |        |        |        |        | 0.5000 (23b)  |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |                             |        |        |        |        |        |        |        |        |        |        | 84.6000 (23c) |
| Effective ac  | 0.3239                      | 0.3190 | 0.3142 | 0.2900 | 0.2851 | 0.2609 | 0.2609 | 0.2561 | 0.2706 | 0.2851 | 0.2948 | 0.3045 (25)   |

### 3. Heat losses and heat loss parameter

| Element   | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K       | A x K<br>kJ/K    |         |         |         |         |              |
|---|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------------|------------------|---------|---------|---------|---------|--------------|
| Front door  |                         |                            | 2.1200                    | 1.5000                        | 3.1800       |                                      | (26)             |         |         |         |         |              |
| Utility Door  |                         |                            | 2.1200                    | 1.2000                        | 2.5440       |                                      | (26a)            |         |         |         |         |              |
| Window (Uw = 0.80)  |                         |                            | 11.2200                   | 0.7752                        | 8.6977       |                                      | (27)             |         |         |         |         |              |
| French Door (Uw = 1.00)   |                         |                            | 5.0400                    | 0.9615                        | 4.8462       |                                      | (27)             |         |         |         |         |              |
| Front   |                         |                            | 1.4000                    | 1.0536                        | 1.4751       |                                      | (27a)            |         |         |         |         |              |
| Ground Floor  |                         |                            | 53.5600                   | 0.1200                        | 6.4272       | 75.0000                              | 4017.0000 (28a)  |         |         |         |         |              |
| External Wall 1   | 128.6600                | 20.5000                    | 108.1600                  | 0.1500                        | 16.2240      | 110.0000                             | 11897.6000 (29a) |         |         |         |         |              |
| Dormer Cheek  | 14.6200                 |                            | 14.6200                   | 0.2100                        | 3.0702       | 9.0000                               | 131.5800 (29a)   |         |         |         |         |              |
| Cold Roof   | 32.1100                 |                            | 32.1100                   | 0.0900                        | 2.8899       | 9.0000                               | 288.9900 (30)    |         |         |         |         |              |
| Sloping Roof  | 15.7200                 | 1.4000                     | 14.3200                   | 0.1300                        | 1.8616       | 9.0000                               | 128.8800 (30)    |         |         |         |         |              |
| Dormer Roof   | 10.9200                 |                            | 10.9200                   | 0.1000                        | 1.0920       | 9.0000                               | 98.2800 (30)     |         |         |         |         |              |
| Total net area of external elements Aum(A, m <sup>2</sup> )         |                         |                            | 255.5900                  |                               |              |                                      | (31)             |         |         |         |         |              |
| Fabric heat loss, W/K = Sum (A x U)                                 |                         |                            |                           | (26)...(30) + (32) =          | 52.3078      |                                      | (33)             |         |         |         |         |              |
| GF  |                         |                            | 68.1300                   |                               |              | 9.0000                               | 613.1700 (32c)   |         |         |         |         |              |
| FF  |                         |                            | 90.7800                   |                               |              | 9.0000                               | 817.0200 (32c)   |         |         |         |         |              |
| Internal Floor 1  |                         |                            | 53.5600                   |                               |              | 18.0000                              | 964.0800 (32d)   |         |         |         |         |              |
| Internal Ceiling 1  |                         |                            | 53.5600                   |                               |              | 9.0000                               | 482.0400 (32e)   |         |         |         |         |              |
| Heat capacity Cm = Sum (A x k)                                      |                         |                            |                           |                               |              | (28)...(30) + (32) + (32a)...(32e) = | 19438.6400 (34)  |         |         |         |         |              |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K      |                         |                            |                           |                               |              |                                      | 181.4660 (35)    |         |         |         |         |              |
| List of Thermal Bridges   |                         |                            |                           |                               |              |                                      |                  |         |         |         |         |              |
| K1 Element  |                         |                            |                           | Length                        | Psi-value    | Total                                |                  |         |         |         |         |              |
| E1 Steel lintel with perforated steel base plate                    |                         |                            |                           | 13.7700                       | 0.0500       | 0.6885                               |                  |         |         |         |         |              |
| E3 Sill   |                         |                            |                           | 9.3500                        | 0.0210       | 0.1963                               |                  |         |         |         |         |              |
| E4 Jamb   |                         |                            |                           | 36.0000                       | 0.0160       | 0.5760                               |                  |         |         |         |         |              |
| E5 Ground floor (normal)  |                         |                            |                           | 29.8500                       | 0.1120       | 3.3432                               |                  |         |         |         |         |              |
| E6 Intermediate floor within a dwelling                             |                         |                            |                           | 29.8500                       | 0.0020       | 0.0597                               |                  |         |         |         |         |              |
| E16 Corner (normal)   |                         |                            |                           | 17.2000                       | 0.0510       | 0.8772                               |                  |         |         |         |         |              |
| R1 Head of roof window  |                         |                            |                           | 1.2700                        | 0.2400       | 0.3048                               |                  |         |         |         |         |              |
| R2 Sill of roof window  |                         |                            |                           | 1.2700                        | 0.2400       | 0.3048                               |                  |         |         |         |         |              |
| R3 Jamb of roof window  |                         |                            |                           | 2.2000                        | 0.2400       | 0.5280                               |                  |         |         |         |         |              |
| E10 Eaves (insulation at ceiling level)                             |                         |                            |                           | 9.6500                        | 0.0630       | 0.6079                               |                  |         |         |         |         |              |
| E11 Eaves (insulation at rafter level)                              |                         |                            |                           | 8.5100                        | 0.0170       | 0.1447                               |                  |         |         |         |         |              |
| E12 Gable (insulation at ceiling level)                             |                         |                            |                           | 16.2900                       | 0.0980       | 1.5964                               |                  |         |         |         |         |              |
| E13 Gable (insulation at rafter level)                              |                         |                            |                           | 4.8300                        | 0.0510       | 0.2463                               |                  |         |         |         |         |              |
| R6 Flat ceiling   |                         |                            |                           | 8.8300                        | 0.0600       | 0.5298                               |                  |         |         |         |         |              |
| R7 Flat ceiling (inverted)  |                         |                            |                           | 18.6800                       | 0.0600       | 1.1208                               |                  |         |         |         |         |              |
| R9 Roof to wall (flat ceiling)                                      |                         |                            |                           | 9.0300                        | 0.1600       | 1.4448                               |                  |         |         |         |         |              |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |                         |                            |                           |                               |              |                                      | 12.5693 (36)     |         |         |         |         |              |
| Point Thermal bridges   |                         |                            |                           |                               |              | (36a) =                              | 0.0000           |         |         |         |         |              |
| Total fabric heat loss  |                         |                            |                           |                               |              | (33) + (36) + (36a) =                | 64.8771 (37)     |         |         |         |         |              |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                         |                            |                           |                               |              |                                      |                  |         |         |         |         |              |
| (38)m   | Jan                     | Feb                        | Mar                       | Apr                           | May          | Jun                                  | Jul              | Aug     | Sep     | Oct     | Nov     | Dec          |
| Heat transfer coeff   | 27.4770                 | 27.0663                    | 26.6557                   | 24.6023                       | 24.1916      | 22.1382                              | 22.1382          | 21.7276 | 22.9596 | 24.1916 | 25.0130 | 25.8343 (38) |

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|                           |         |         |         |         |         |         |         |         |         |         |         |              |
|---------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Average = Sum(39)m / 12 = | 92.3541 | 91.9435 | 91.5328 | 89.4794 | 89.0688 | 87.0154 | 87.0154 | 86.6047 | 87.8367 | 89.0688 | 89.8901 | 90.7114 (39) |
|                           | 89.3768 |         |         |         |         |         |         |         |         |         |         |              |
| HLP                       | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
| HLP (average)             | 0.8622  | 0.8583  | 0.8545  | 0.8353  | 0.8315  | 0.8123  | 0.8123  | 0.8085  | 0.8200  | 0.8315  | 0.8392  | 0.8468 (40)  |
| Days in mont              | 31      | 28      | 31      | 30      | 31      | 30      | 31      | 31      | 30      | 31      | 30      | 31           |

## 4. Water heating energy requirements (kWh/year)

|   |          |          |          |          |          |          |          |          |          |          |          |               |               |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|---------------|
| Assumed occupancy   |          |          |          |          |          |          |          |          |          |          |          |               | 2.7964 (42)   |
| Hot water usage for mixer showers                               | 71.1060  | 70.0375  | 68.4803  | 65.5010  | 63.3024  | 60.8504  | 59.4568  | 61.0021  | 62.6961  | 65.3287  | 68.3720  | 70.8336 (42a) |               |
| Hot water usage for baths                                       | 30.7011  | 30.2452  | 29.6031  | 28.4192  | 27.5328  | 26.5498  | 26.0188  | 26.6564  | 27.3507  | 28.4025  | 29.6107  | 30.5974 (42b) |               |
| Hot water usage for other uses                                  | 43.2678  | 41.6944  | 40.1211  | 38.5477  | 36.9743  | 35.4009  | 35.4009  | 36.9743  | 38.5477  | 40.1211  | 41.6944  | 43.2678 (42c) |               |
| Average daily hot water use (litres/day)                        |          |          |          |          |          |          |          |          |          |          |          |               | 133.3566 (43) |
| Daily hot water use   | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |               |
| Energy conte  | 145.0750 | 141.9771 | 138.2045 | 132.4679 | 127.8094 | 122.8012 | 120.8766 | 124.6329 | 128.5945 | 133.8523 | 139.6772 | 144.6988 (44) |               |
| Energy content (annual)   | 229.7633 | 202.1735 | 212.4151 | 181.3420 | 172.0561 | 150.9984 | 146.1897 | 154.3215 | 158.5698 | 181.6362 | 198.9958 | 226.5633 (45) |               |
| Distribution loss (46)m = 0.15 x (45)m                          |          |          |          |          |          |          |          |          |          |          |          |               | 2215.0247     |
| Water storage loss:   | 34.4645  | 30.3260  | 31.8623  | 27.2013  | 25.8084  | 22.6498  | 21.9285  | 23.1482  | 23.7855  | 27.2454  | 29.8494  | 33.9845 (46)  |               |
| Store volume  |          |          |          |          |          |          |          |          |          |          |          |               | 250.0000 (47) |
| a) If manufacturer declared loss factor is known (kWh/day):     |          |          |          |          |          |          |          |          |          |          |          |               | 1.4000 (48)   |
| Temperature factor from Table 2b                                |          |          |          |          |          |          |          |          |          |          |          |               | 0.5400 (49)   |
| Enter (49) or (54) in (55)                                      |          |          |          |          |          |          |          |          |          |          |          |               | 0.7560 (55)   |
| Total storage loss  | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (56)  |               |
| If cylinder contains dedicated solar storage                    | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (57)  |               |
| Primary loss  | 23.2624  | 21.0112  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624 (59)  |               |
| Combi loss  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (61)   |               |
| Total heat required for water heating calculated for each month | 276.4617 | 244.3527 | 259.1135 | 226.5340 | 218.7545 | 196.1904 | 192.8881 | 201.0199 | 203.7618 | 228.3346 | 244.1878 | 273.2617 (62) |               |
| WWHRS   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63a)  |               |
| FV diverter   | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000 (63b) |               |
| Solar input   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63c)  |               |
| FGHRS   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63d)  |               |
| Output from w/h   | 276.4617 | 244.3527 | 259.1135 | 226.5340 | 218.7545 | 196.1904 | 192.8881 | 201.0199 | 203.7618 | 228.3346 | 244.1878 | 273.2617 (64) |               |
| Electric shower(s)  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (64a)  |               |
| Heat gains from water heating, kWh/month                        | 113.7550 | 100.9660 | 107.9868 | 96.4498  | 94.5674  | 86.3606  | 85.9668  | 88.6706  | 88.8781  | 97.7528  | 102.3197 | 112.6910 (65) |               |

## 5. Internal gains (see Table 5 and 5a)

|   |           |           |           |           |           |           |           |           |           |           |           |                |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| Metabolic gains (Table 5), Watts  | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec            |
| (66)m   | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833  | 167.7833 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 34.4134   | 30.5656   | 24.8577   | 18.8188   | 14.0673   | 11.8762   | 12.8327   | 16.6804   | 22.3884   | 28.4272   | 33.1787   | 35.3698 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 399.0320  | 403.1727  | 392.7382  | 370.5246  | 342.4838  | 316.1294  | 298.5230  | 294.3823  | 304.8168  | 327.0304  | 355.0712  | 381.4256 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747 (69)   |
| Pumps, fans   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 (71) |
| Water heating gains (Table 5)   | 152.8965  | 150.2471  | 145.1435  | 133.9581  | 127.1067  | 119.9452  | 115.5468  | 119.1810  | 123.4418  | 131.3881  | 142.1107  | 151.4664 (72)  |
| Total internal gains  | 696.8444  | 694.4879  | 673.2419  | 633.8039  | 594.1602  | 558.4533  | 537.4050  | 540.7461  | 561.1494  | 597.3482  | 640.8631  | 678.7643 (73)  |

## 6. Solar gains

|             |          |            |               |               |           |               |           |           |           |          |          |               |
|-------------|----------|------------|---------------|---------------|-----------|---------------|-----------|-----------|-----------|----------|----------|---------------|
| [Jan]       | Area     | Solar flux | g             | FF            | Access    | Gains         |           |           |           |          |          |               |
|             | m2       | Table 6a   | Specific data | Specific data | factor    | W             |           |           |           |          |          |               |
|             |          | W/m2       | or Table 6b   | or Table 6c   | Table 6d  |               |           |           |           |          |          |               |
| North       | 4.8500   | 10.6334    | 0.5800        | 0.0000        | 0.7700    | 23.0320 (74)  |           |           |           |          |          |               |
| East        | 0.7600   | 19.6403    | 0.5800        | 0.0000        | 0.7700    | 6.6662 (76)   |           |           |           |          |          |               |
| South       | 5.6100   | 46.7521    | 0.5800        | 0.0000        | 0.7700    | 117.1338 (78) |           |           |           |          |          |               |
| North       | 5.0400   | 10.6334    | 0.6300        | 0.7000        | 0.7700    | 16.3785 (74)  |           |           |           |          |          |               |
| South       | 1.4000   | 47.0123    | 0.6300        | 0.7000        | 1.0000    | 26.1229 (82)  |           |           |           |          |          |               |
| Solar gains | 189.3335 | 326.8103   | 462.0126      | 602.9460      | 707.2243  | 717.2106      | 685.1038  | 604.2845  | 509.9668  | 364.8702 | 227.4790 | 161.6212 (83) |
| Total gains | 886.1778 | 1021.2981  | 1135.2545     | 1236.7500     | 1301.3845 | 1275.6639     | 1222.5087 | 1145.0306 | 1071.1162 | 962.2185 | 868.3421 | 840.3855 (84) |

## 7. Mean internal temperature (heating season)

|   |         |         |         |         |         |         |         |         |         |         |         |             |              |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|-------------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         |             | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec         |              |
| tau   | 58.4665 | 58.7276 | 58.9911 | 60.3448 | 60.6231 | 62.0537 | 62.0537 | 62.3479 | 61.4734 | 60.6231 | 60.0692 | 59.5253     |              |
| alpha   | 4.8978  | 4.9152  | 4.9327  | 5.0230  | 5.0415  | 5.1369  | 5.1369  | 5.1565  | 5.0982  | 5.0415  | 5.0046  | 4.9684      |              |
| util living area  | 0.9707  | 0.9437  | 0.8892  | 0.7740  | 0.6111  | 0.4331  | 0.3126  | 0.3469  | 0.5519  | 0.8182  | 0.9444  | 0.9760 (86) |              |
| Living  | 20.0660 | 20.2921 | 20.5641 | 20.8271 | 20.9544 | 20.9938 | 20.9991 | 20.9984 | 20.9794 | 20.8082 | 20.4086 | 20.0327     |              |

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|                        |         |         |         |         |         |         |         |         |                           |         |         |              |
|------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| Non living             | 19.1220 | 19.4047 | 19.7368 | 20.0526 | 20.1876 | 20.2387 | 20.2423 | 20.2453 | 20.2215                   | 20.0419 | 19.5660 | 19.0904      |
| 24 / 16                | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0       | 0            |
| 24 / 9                 | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0       | 0            |
| 16 / 9                 | 28      | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0       | 10           |
| MIT                    | 20.5222 | 20.2921 | 20.5641 | 20.8271 | 20.9544 | 20.9938 | 20.9991 | 20.9984 | 20.9794                   | 20.8082 | 20.4086 | 20.1680 (87) |
| Th 2                   | 20.1998 | 20.2031 | 20.2064 | 20.2228 | 20.2261 | 20.2427 | 20.2427 | 20.2460 | 20.2360                   | 20.2261 | 20.2195 | 20.2129 (88) |
| util rest of house     |         |         |         |         |         |         |         |         |                           |         |         |              |
|                        | 0.9648  | 0.9332  | 0.8701  | 0.7414  | 0.5668  | 0.3831  | 0.2591  | 0.2905  | 0.4955                    | 0.7829  | 0.9322  | 0.9711 (89)  |
| MIT 2                  | 19.7701 | 19.4047 | 19.7368 | 20.0526 | 20.1876 | 20.2387 | 20.2423 | 20.2453 | 20.2215                   | 20.0419 | 19.5660 | 19.2927 (90) |
| Living area fraction   |         |         |         |         |         |         |         |         | FLA = Living area / (4) = |         |         | 0.3780 (91)  |
| MIT                    | 20.0544 | 19.7402 | 20.0495 | 20.3454 | 20.4774 | 20.5241 | 20.5283 | 20.5300 | 20.5080                   | 20.3316 | 19.8845 | 19.6235 (92) |
| Temperature adjustment |         |         |         |         |         |         |         |         |                           |         |         | 0.0000       |
| adjusted MIT           | 20.0544 | 19.7402 | 20.0495 | 20.3454 | 20.4774 | 20.5241 | 20.5283 | 20.5300 | 20.5080                   | 20.3316 | 19.8845 | 19.6235 (93) |

## 8. Space heating requirement

|  | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec                        |
|--|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------------------|
| Utilisation  | 0.9636    | 0.9261    | 0.8660    | 0.7468    | 0.5815   | 0.4018   | 0.2793   | 0.3118   | 0.5159   | 0.7881   | 0.9262    | 0.9667 (94)                |
| Useful gains   | 853.8982  | 945.8529  | 983.0999  | 923.5930  | 756.7319 | 512.5533 | 341.4710 | 357.0634 | 552.6061 | 758.2807 | 804.2206  | 812.3813 (95)              |
| Ext temp.  | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000  | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000  | 7.1000    | 4.2000 (96)                |
| Heat loss rate W   |           |           |           |           |          |          |          |          |          |          |           |                            |
|  | 1454.9834 | 1364.4563 | 1240.2228 | 1024.1253 | 781.7961 | 515.4883 | 341.8246 | 357.6736 | 562.8547 | 866.7774 | 1149.2001 | 1399.0925 (97)             |
| Space heating kWh  | 447.2074  | 281.3015  | 191.2994  | 72.3833   | 18.6478  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 80.7215  | 248.3852  | 436.5131 (98a)             |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |          |          |          |          |          |          |           | 1776.4592                  |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000 (98b)               |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |          |          |          |          |          |          |           | 0.0000                     |
| Space heating kWh  | 447.2074  | 281.3015  | 191.2994  | 72.3833   | 18.6478  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 80.7215  | 248.3852  | 436.5131 (98c)             |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |          |          |          |          |          |          |           | 1776.4592                  |
| Space heating per m2   |           |           |           |           |          |          |          |          |          |          |           | (98c) / (4) = 16.5838 (99) |

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

| Fraction of space heat from secondary/supplementary system (Table 11)   |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (201)     |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------------|
| Fraction of space heat from main system(s)  |           |           |           |           |           |           |           |           |           |           |           | 1.0000 (202)     |
| Efficiency of main space heating system 1 (in %)  |           |           |           |           |           |           |           |           |           |           |           | 273.8380 (206)   |
| Efficiency of main space heating system 2 (in %)  |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (207)     |
| Efficiency of secondary/supplementary heating system, %   |           |           |           |           |           |           |           |           |           |           |           | 60.0000 (208)    |
|   | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec              |
| Space heating requirement   | 447.2074  | 281.3015  | 191.2994  | 72.3833   | 18.6478   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 80.7215   | 248.3852  | 436.5131 (98)    |
| Space heating efficiency (main heating system 1)  | 273.8380  | 273.8380  | 273.8380  | 273.8380  | 273.8380  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 273.8380  | 273.8380  | 273.8380 (210)   |
| Space heating fuel (main heating system)  | 163.3109  | 102.7255  | 69.8586   | 26.4329   | 6.8098    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 29.4778   | 90.7052   | 159.4056 (211)   |
| Space heating efficiency (main heating system 2)  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (212)     |
| Space heating fuel (main heating system 2)  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (213)     |
| Space heating fuel (secondary)  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (215)     |
| Water heating   |           |           |           |           |           |           |           |           |           |           |           |                  |
| Water heating requirement   | 276.4617  | 244.3527  | 259.1135  | 226.5340  | 218.7545  | 196.1904  | 192.8881  | 201.0199  | 203.7618  | 228.3346  | 244.1878  | 273.2617 (64)    |
| Efficiency of water heater (217)m   | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490 (216)   |
| Fuel for water heating, kWh/month   | 97.2262   | 85.9341   | 91.1252   | 79.6676   | 76.9317   | 68.9963   | 67.8350   | 70.6948   | 71.6591   | 80.3008   | 85.8761   | 96.1008 (219)    |
| Space cooling fuel requirement (221)m   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (221)     |
| Pumps and Fa  | 18.9800   | 17.1432   | 18.9800   | 18.3677   | 18.9800   | 18.3677   | 18.9800   | 18.9800   | 18.3677   | 18.9800   | 18.3677   | 18.9800 (231)    |
| Lighting  | 30.1218   | 24.1648   | 21.7578   | 15.9407   | 12.3130   | 10.0598   | 11.2324   | 14.6002   | 18.9643   | 24.8821   | 28.1043   | 30.9590 (232)    |
| Electricity generated by PVs (Appendix M) (negative quantity) (233a)m   | -61.1968  | -84.5389  | -117.4902 | -126.5337 | -133.4149 | -123.3776 | -122.0874 | -116.2111 | -105.1403 | -92.4702  | -66.0775  | -53.0845 (233a)  |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m   | -212.5732 | -192.0016 | -212.5732 | -205.7160 | -212.5732 | -205.7160 | -212.5732 | -212.5732 | -205.7160 | -212.5732 | -205.7160 | -212.5732 (234a) |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (235a)    |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (235c)    |
| Electricity generated by PVs (Appendix M) (negative quantity) (233b)m   | -28.3447  | -59.7936  | -116.2568 | -171.5859 | -223.4746 | -223.2536 | -221.7264 | -191.4592 | -146.4634 | -88.6194  | -39.0938  | -22.5658 (233b)  |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m   | -91.1028  | -82.2864  | -91.1028  | -88.1640  | -91.1028  | -88.1640  | -91.1028  | -91.1028  | -88.1640  | -91.1028  | -88.1640  | -91.1028 (234b)  |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (235b)    |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (235d)    |
| Annual totals kWh/year  |           |           |           |           |           |           |           |           |           |           |           |                  |
| Space heating fuel - main system 1  |           |           |           |           |           |           |           |           |           |           |           | 648.7263 (211)   |
| Space heating fuel - main system 2  |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (213)     |
| Space heating fuel - secondary  |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (215)     |
| Efficiency of water heater  |           |           |           |           |           |           |           |           |           |           |           | 284.3490         |
| Water heating fuel used   |           |           |           |           |           |           |           |           |           |           |           | 972.3475 (219)   |
| Space cooling fuel  |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (221)     |
| Electricity for pumps and fans:<br>(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7125)<br>mechanical ventilation fans (SFP = 0.7125) |           |           |           |           |           |           |           |           |           |           |           | 223.4737 (230a)  |
| Total electricity for the above, kWh/year   |           |           |           |           |           |           |           |           |           |           |           | 223.4737 (231)   |
| Electricity for lighting (calculated in Appendix L)   |           |           |           |           |           |           |           |           |           |           |           | 243.1003 (232)   |
| Energy saving/generation technologies (Appendices M ,N and Q)   |           |           |           |           |           |           |           |           |           |           |           |                  |
| PV generation   |           |           |           |           |           |           |           |           |           |           |           | -2734.2604 (233) |
| Wind generation   |           |           |           |           |           |           |           |           |           |           |           | -3575.5408 (234) |
| Hydro-electric generation (Appendix N)  |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (235a)    |
| Electricity generated - Micro CHP (Appendix N)  |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (235)     |
| Appendix Q - special features   |           |           |           |           |           |           |           |           |           |           |           |                  |
| Energy saved or generated   |           |           |           |           |           |           |           |           |           |           |           | -0.0000 (236)    |
| Energy used   |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (237)     |
| Total delivered energy for all uses   |           |           |           |           |           |           |           |           |           |           |           | -4222.1534 (238) |

# Full SAP Calculation Printout



## 10a. Fuel costs - using Table 12 prices

|   | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |        |
|---|---------------|------------------|------------------|--------|
| Space heating - main system 1               | 648.7263      | 16.4900          | 106.9750         | (240)  |
| Total CO2 associated with community systems |               |                  | 0.0000           | (473)  |
| Water heating (other fuel)                  | 972.3475      | 16.4900          | 160.3401         | (247)  |
| Energy for instantaneous electric shower(s) | 0.0000        | 16.4900          | 0.0000           | (247a) |
| Pumps, fans and electric keep-hot           | 223.4737      | 16.4900          | 36.8508          | (249)  |
| Energy for lighting                         | 243.1003      | 16.4900          | 40.0872          | (250)  |
| Additional standing charges                 |               |                  | 0.0000           | (251)  |
| Energy saving/generation technologies       |               |                  |                  |        |
| PV Unit electricity used in dwelling        | -1201.6232    | 16.4900          | -198.1477        |        |
| PV Unit electricity exported                | -1532.6372    | 5.5900           | -85.6744         |        |
| Total                                       |               |                  | -283.8221        | (252)  |
| Wind Turbine electricity used in dwelling   | -2502.8785    | 16.4900          | -412.7247        |        |
| Wind Turbine electricity exported           | -1072.6622    | 5.5900           | -59.9618         |        |
| Total                                       |               |                  | -472.6865        | (252)  |
| Total energy cost                           |               |                  | -412.2555        | (255)  |

## 11a. SAP rating - Individual heating systems

|                                  |   |          |       |
|----------------------------------|---|----------|-------|
| Energy cost deflator (Table 12): |   | 0.3600   | (256) |
| Energy cost factor (ECF)         | $[(255) \times (256)] / [(4) + 45.0] =$ | -0.9756  | (257) |
| SAP value                        |   | 115.8149 |       |
| SAP rating (Section 12)          |   | 116      | (258) |
| SAP band                         |   | A        |       |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|   | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |       |
|---|-----------------|----------------------------|-----------------------|-------|
| Space heating - main system 1               | 648.7263        | 0.1574                     | 102.1115              | (261) |
| Total CO2 associated with community systems |                 |                            | 0.0000                | (373) |
| Water heating (other fuel)                  | 972.3475        | 0.1410                     | 137.1090              | (264) |
| Space and water heating                     |                 |                            | 239.2205              | (265) |
| Pumps, fans and electric keep-hot           | 223.4737        | 0.1387                     | 30.9986               | (267) |
| Energy for lighting                         | 243.1003        | 0.1443                     | 35.0869               | (268) |
| Energy saving/generation technologies       |                 |                            |                       |       |
| PV Unit electricity used in dwelling        | -1201.6232      | 0.1353                     | -162.5886             |       |
| PV Unit electricity exported                | -1532.6372      | 0.1263                     | -193.6043             |       |
| Total                                       |                 |                            | -356.1929             | (269) |
| Wind Turbine electricity used in dwelling   | -2502.8785      | 0.1387                     | -347.1801             |       |
| Wind Turbine electricity exported           | -1072.6622      | 0.1387                     | -148.7915             |       |
| Total                                       |                 |                            | -495.9716             | (269) |
| Total CO2, kg/year                          |                 |                            | -546.8586             | (272) |
| CO2 emissions per m2                        |                 |                            | -5.1100               | (273) |
| EI value                                    |                 |                            | 104.8172              |       |
| EI rating                                   |                 |                            | 105                   | (274) |
| EI band                                     |                 |                            | A                     |       |

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)  
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING

## 1. Overall dwelling characteristics

|  | Area (m2)    | Storey height (m)               | Volume (m3)            |  |
|--|--------------|---------------------------------|------------------------|--|
| Ground floor   | 53.5600 (1b) | x 2.5000 (2b)                   | = 133.9000 (1b) - (3b) |  |
| First floor  | 53.5600 (1c) | x 2.3000 (2c)                   | = 123.1880 (1c) - (3c) |  |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 107.1200     |                                 | (4)                    |  |
| Dwelling volume  |              | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 257.0880 (5)         |  |

## 2. Ventilation rate

|  |                 |              |
|--|-----------------|--------------|
| Number of open chimneys  | 0 * 80 =        | 0.0000 (6a)  |
| Number of open flues   | 1 * 20 =        | 20.0000 (6b) |
| Number of chimneys / flues attached to closed fire   | 0 * 10 =        | 0.0000 (6c)  |
| Number of flues attached to solid fuel boiler  | 0 * 20 =        | 0.0000 (6d)  |
| Number of flues attached to other heater   | 0 * 35 =        | 0.0000 (6e)  |
| Number of blocked chimneys   | 0 * 20 =        | 0.0000 (6f)  |
| Number of intermittent extract fans  | 0 * 10 =        | 0.0000 (7a)  |
| Number of passive vents  | 0 * 10 =        | 0.0000 (7b)  |
| Number of flueless gas fires   | 0 * 40 =        | 0.0000 (7c)  |
| Air changes per hour   |                 |              |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 20.0000 / (5) = | 0.0778 (8)   |
| Pressure test  |                 | Yes          |
| Pressure Test Method   |                 | Blower Door  |
| Measured/design AP50   |                 | 3.0000 (17)  |
| Infiltration rate  |                 | 0.2278 (18)  |

# Full SAP Calculation Printout



Number of sides sheltered

2 (19)

Shelter factor (20) = 1 - [0.075 x (19)] = 0.8500 (20)  
 Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.1936 (21)

|   | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec           |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------------|
| Wind speed  | 6.3000 | 6.0000 | 5.8000 | 5.1000 | 5.1000 | 4.6000 | 4.6000 | 4.5000 | 4.9000 | 5.7000 | 5.9000 | 6.3000 (22)   |
| Wind factor   | 1.5750 | 1.5000 | 1.4500 | 1.2750 | 1.2750 | 1.1500 | 1.1500 | 1.1250 | 1.2250 | 1.4250 | 1.4750 | 1.5750 (22a)  |
| Adj infilt rate   | 0.3050 | 0.2904 | 0.2808 | 0.2469 | 0.2469 | 0.2227 | 0.2227 | 0.2178 | 0.2372 | 0.2759 | 0.2856 | 0.3050 (22b)  |
| Balanced mechanical ventilation with heat recovery  |        |        |        |        |        |        |        |        |        |        |        |               |
| If mechanical ventilation   |        |        |        |        |        |        |        |        |        |        |        | 0.5000 (23a)  |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |        |        |        |        |        |        |        |        |        |        |        | 0.5000 (23b)  |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |        |        |        |        |        |        |        |        |        |        |        | 84.6000 (23c) |
| Effective ac  | 0.3820 | 0.3674 | 0.3578 | 0.3239 | 0.3239 | 0.2997 | 0.2997 | 0.2948 | 0.3142 | 0.3529 | 0.3626 | 0.3820 (25)   |

### 3. Heat losses and heat loss parameter

| Element  | Gross m2 | Openings m2 | NetArea m2 | U-value W/m2K | A x U W/K                    | K-value kJ/m2K | A x K kJ/K       |
|--|----------|-------------|------------|---------------|------------------------------|----------------|------------------|
| Front door                                     |          |             | 2.1200     | 1.5000        | 3.1800                       |                | (26)             |
| Utility Door                                   |          |             | 2.1200     | 1.2000        | 2.5440                       |                | (26a)            |
| Window (Uw = 0.80)                             |          |             | 11.2200    | 0.7752        | 8.6977                       |                | (27)             |
| French Door (Uw = 1.00)                        |          |             | 5.0400     | 0.9615        | 4.8462                       |                | (27)             |
| Front  |          |             | 1.4000     | 1.0536        | 1.4751                       |                | (27a)            |
| Ground Floor                                   |          |             | 53.5600    | 0.1200        | 6.4272                       | 75.0000        | 4017.0000 (28a)  |
| External Wall 1                                | 128.6600 | 20.5000     | 108.1600   | 0.1500        | 16.2240                      | 110.0000       | 11897.6000 (29a) |
| Dormer Cheek                                   | 14.6200  |             | 14.6200    | 0.2100        | 3.0702                       | 9.0000         | 131.5800 (29a)   |
| Cold Roof                                      | 32.1100  |             | 32.1100    | 0.0900        | 2.8899                       | 9.0000         | 288.9900 (30)    |
| Sloping Roof                                   | 15.7200  | 1.4000      | 14.3200    | 0.1300        | 1.8616                       | 9.0000         | 128.8800 (30)    |
| Dormer Roof                                    | 10.9200  |             | 10.9200    | 0.1000        | 1.0920                       | 9.0000         | 98.2800 (30)     |
| Total net area of external elements Aum(A, m2) |          |             | 255.5900   |               |                              |                | (31)             |
| Fabric heat loss, W/K = Sum (A x U)            |          |             |            |               | (26)...(30) + (32) = 52.3078 |                | (33)             |
| GF   |          |             | 68.1300    |               |                              | 9.0000         | 613.1700 (32c)   |
| FF   |          |             | 90.7800    |               |                              | 9.0000         | 817.0200 (32c)   |
| Internal Floor 1                               |          |             | 53.5600    |               |                              | 18.0000        | 964.0800 (32d)   |
| Internal Ceiling 1                             |          |             | 53.5600    |               |                              | 9.0000         | 482.0400 (32e)   |

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 19438.6400 (34)  
 Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 181.4660 (35)

#### List of Thermal Bridges

| K1 Element                                       | Length  | Psi-value | Total  |
|--|---------|-----------|--------|
| E1 Steel lintel with perforated steel base plate | 13.7700 | 0.0500    | 0.6885 |
| E3 Sill  | 9.3500  | 0.0210    | 0.1963 |
| E4 Jamb  | 36.0000 | 0.0160    | 0.5760 |
| E5 Ground floor (normal)                         | 29.8500 | 0.1120    | 3.3432 |
| E6 Intermediate floor within a dwelling          | 29.8500 | 0.0020    | 0.0597 |
| E16 Corner (normal)                              | 17.2000 | 0.0510    | 0.8772 |
| R1 Head of roof window                           | 1.2700  | 0.2400    | 0.3048 |
| R2 Sill of roof window                           | 1.2700  | 0.2400    | 0.3048 |
| R3 Jamb of roof window                           | 2.2000  | 0.2400    | 0.5280 |
| E10 Eaves (insulation at ceiling level)          | 9.6500  | 0.0630    | 0.6079 |
| E11 Eaves (insulation at rafter level)           | 8.5100  | 0.0170    | 0.1447 |
| E12 Gable (insulation at ceiling level)          | 16.2900 | 0.0980    | 1.5964 |
| E13 Gable (insulation at rafter level)           | 4.8300  | 0.0510    | 0.2463 |
| R6 Flat ceiling                                  | 8.8300  | 0.0600    | 0.5298 |
| R7 Flat ceiling (inverted)                       | 18.6800 | 0.0600    | 1.1208 |
| R9 Roof to wall (flat ceiling)                   | 9.0300  | 0.1600    | 1.4448 |

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 12.5693 (36)  
 Point Thermal bridges 0.0000 (36a) =  
 Total fabric heat loss (33) + (36) + (36a) = 64.8771 (37)

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

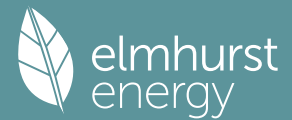
| (38)m                     | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
|---------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Heat transfer coeff       | 32.4051 | 31.1731 | 30.3517 | 27.4770 | 27.4770 | 25.4236 | 25.4236 | 25.0130 | 26.6557 | 29.9410 | 30.7624 | 32.4051 (38) |
| Average = Sum(39)m / 12 = | 97.2822 | 96.0502 | 95.2289 | 92.3541 | 92.3541 | 90.3008 | 90.3008 | 89.8901 | 91.5328 | 94.8182 | 95.6395 | 97.2822 (39) |

|               | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec         |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| HLP           | 0.9082 | 0.8967 | 0.8890 | 0.8622 | 0.8622 | 0.8430 | 0.8430 | 0.8392 | 0.8545 | 0.8852 | 0.8928 | 0.9082 (40) |
| HLP (average) |        |        |        |        |        |        |        |        |        |        |        | 0.8737      |
| Days in mont  | 31     | 28     | 31     | 30     | 31     | 30     | 31     | 31     | 30     | 31     | 30     | 31          |

### 4. Water heating energy requirements (kWh/year)

| Assumed occupancy   | 2.7964 (42) |          |          |          |          |          |          |          |          |          |          |                              |
|---|-------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|------------------------------|
| Hot water usage for mixer showers                           | 71.1060     | 70.0375  | 68.4803  | 65.5010  | 63.3024  | 60.8504  | 59.4568  | 61.0021  | 62.6961  | 65.3287  | 68.3720  | 70.8336 (42a)                |
| Hot water usage for baths                                   | 30.7011     | 30.2452  | 29.6031  | 28.4192  | 27.5328  | 26.5498  | 26.0188  | 26.6564  | 27.3507  | 28.4025  | 29.6107  | 30.5974 (42b)                |
| Hot water usage for other uses                              | 43.2678     | 41.6944  | 40.1211  | 38.5477  | 36.9743  | 35.4009  | 35.4009  | 36.9743  | 38.5477  | 40.1211  | 41.6944  | 43.2678 (42c)                |
| Average daily hot water use (litres/day)                    |             |          |          |          |          |          |          |          |          |          |          | 133.3566 (43)                |
| Daily hot water use   | 145.0750    | 141.9771 | 138.2045 | 132.4679 | 127.8094 | 122.8012 | 120.8766 | 124.6329 | 128.5945 | 133.8523 | 139.6772 | 144.6988 (44)                |
| Energy conte  | 229.7633    | 202.1735 | 212.4151 | 181.3420 | 172.0561 | 150.9984 | 146.1897 | 154.3215 | 158.5698 | 181.6362 | 198.9958 | 226.5633 (45)                |
| Energy content (annual)                                     |             |          |          |          |          |          |          |          |          |          |          | Total = Sum(45)m = 2215.0247 |
| Distribution loss (46)m = 0.15 x (45)m                      | 34.4645     | 30.3260  | 31.8623  | 27.2013  | 25.8084  | 22.6498  | 21.9285  | 23.1482  | 23.7855  | 27.2454  | 29.8494  | 33.9845 (46)                 |
| Water storage loss:   |             |          |          |          |          |          |          |          |          |          |          |                              |
| Store volume  |             |          |          |          |          |          |          |          |          |          |          | 250.0000 (47)                |
| a) If manufacturer declared loss factor is known (kWh/day): |             |          |          |          |          |          |          |          |          |          |          | 1.4000 (48)                  |
| Temperature factor from Table 2b                            |             |          |          |          |          |          |          |          |          |          |          | 0.5400 (49)                  |
| Enter (49) or (54) in (55)                                  |             |          |          |          |          |          |          |          |          |          |          | 0.7560 (55)                  |
| Total storage loss  | 23.4360     | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (56)                 |
| If cylinder contains dedicated solar storage                | 23.4360     | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (57)                 |
| Primary loss  | 23.2624     | 21.0112  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624 (59)                 |

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|   |  |          |          |          |          |          |          |          |          |          |          |           |       |
|---|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-------|
| Combi loss  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (61)  |
| Total heat required for water heating calculated for each month | 276.4617   | 244.3527 | 259.1135 | 226.5340 | 218.7545 | 196.1904 | 192.8881 | 201.0199 | 203.7618 | 228.3346 | 244.1878 | 273.2617  | (62)  |
| WWHRS   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (63a) |
| PV diverter   | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000   | (63b) |
| Solar input   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (63c) |
| FGHRS   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (63d) |
| Output from w/h   | 276.4617   | 244.3527 | 259.1135 | 226.5340 | 218.7545 | 196.1904 | 192.8881 | 201.0199 | 203.7618 | 228.3346 | 244.1878 | 273.2617  | (64)  |
|   | Total per year (kWh/year) = Sum(64)m =   |          |          |          |          |          |          |          |          |          |          | 2764.8607 | (64)  |
| Electric shower(s)  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (64a) |
|   | Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = |          |          |          |          |          |          |          |          |          |          | 0.0000    | (64a) |
| Heat gains from water heating, kWh/month                        | 113.7550   | 100.9660 | 107.9868 | 96.4498  | 94.5674  | 86.3606  | 85.9668  | 88.6706  | 88.8781  | 97.7528  | 102.3197 | 112.6910  | (65)  |

## 5. Internal gains (see Table 5 and 5a)

|   |           |           |           |           |           |           |           |           |           |           |           |           |      |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------|
| Metabolic gains (Table 5), Watts  |           |           |           |           |           |           |           |           |           |           |           |           |      |
| (66)m   | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec       | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 34.4134   | 30.5656   | 24.8577   | 18.8188   | 14.0673   | 11.8762   | 12.8327   | 16.6804   | 22.3884   | 28.4272   | 33.1787   | 35.3698   | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 399.0320  | 403.1727  | 392.7382  | 370.5246  | 342.4838  | 316.1294  | 298.5230  | 294.3823  | 304.8168  | 327.0304  | 355.0712  | 381.4256  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | 54.5747   | (69) |
| Pumps, fans   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | (71) |
| Water heating gains (Table 5)   | 152.8965  | 150.2471  | 145.1435  | 133.9581  | 127.1067  | 119.9452  | 115.5468  | 119.1810  | 123.4418  | 131.3881  | 142.1107  | 151.4664  | (72) |
| Total internal gains  | 696.8444  | 694.4879  | 673.2419  | 633.8039  | 594.1602  | 558.4533  | 537.4050  | 540.7461  | 561.1494  | 597.3482  | 640.8631  | 678.7643  | (73) |

## 6. Solar gains

|             |            |                                |                                   |                                    |                              |               |           |           |           |           |          |          |      |
|-------------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|---------------|-----------|-----------|-----------|-----------|----------|----------|------|
| [Jan]       | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | Specific data<br>g<br>or Table 6b | Specific data<br>FF<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W    |           |           |           |           |          |          |      |
| North       | 4.8500     | 14.1804                        | 0.5800                            | 0.0000                             | 0.7700                       | 30.7149 (74)  |           |           |           |           |          |          |      |
| East        | 0.7600     | 26.5524                        | 0.5800                            | 0.0000                             | 0.7700                       | 9.0123 (76)   |           |           |           |           |          |          |      |
| South       | 5.6100     | 59.0235                        | 0.5800                            | 0.0000                             | 0.7700                       | 147.8791 (78) |           |           |           |           |          |          |      |
| North       | 5.0400     | 14.1804                        | 0.6300                            | 0.7000                             | 0.7700                       | 21.8419 (74)  |           |           |           |           |          |          |      |
| South       | 1.4000     | 61.2906                        | 0.6300                            | 0.7000                             | 1.0000                       | 34.0567 (82)  |           |           |           |           |          |          |      |
| Solar gains | 243.5049   | 361.5405                       | 505.4843                          | 682.9859                           | 758.0677                     | 834.3107      | 720.0570  | 680.9105  | 583.5795  | 414.5551  | 282.0103 | 207.1747 | (83) |
| Total gains | 940.3493   | 1056.0284                      | 1178.7261                         | 1316.7899                          | 1352.2279                    | 1392.7640     | 1257.4619 | 1221.6566 | 1144.7289 | 1011.9034 | 922.8734 | 885.9391 | (84) |

## 7. Mean internal temperature (heating season)

|   |                           |         |         |         |         |         |         |         |         |         |         |         |         |      |
|---|---------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |                           |         |         |         |         |         |         |         |         |         |         |         | 21.0000 | (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |                           |         |         |         |         |         |         |         |         |         |         |         |         |      |
| tau   | Jan                       | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec     |         |      |
| alpha   | 4.7003                    | 4.7478  | 4.7801  | 4.8978  | 4.8978  | 4.9864  | 4.9864  | 5.0046  | 4.9327  | 4.7965  | 4.7639  | 4.7003  |         |      |
| util living area  | 0.9437                    | 0.9130  | 0.8466  | 0.7220  | 0.5859  | 0.4119  | 0.3436  | 0.3302  | 0.4878  | 0.7394  | 0.8904  | 0.9493  | (86)    |      |
| Living  | 20.3049                   | 20.4573 | 20.6735 | 20.8728 | 20.9593 | 20.9942 | 20.9981 | 20.9985 | 20.9875 | 20.8826 | 20.6220 | 20.2948 |         |      |
| Non living  | 19.3907                   | 19.5816 | 19.8403 | 20.0797 | 20.1664 | 20.2125 | 20.2153 | 20.2189 | 20.1984 | 20.0786 | 19.7862 | 19.3798 |         |      |
| 24 / 16   | 0                         | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       |         |      |
| 24 / 9  | 3                         | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       |         |      |
| 16 / 9  | 28                        | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 10      |         |      |
| MIT   | 20.6444                   | 20.4573 | 20.6735 | 20.8728 | 20.9593 | 20.9942 | 20.9981 | 20.9985 | 20.9875 | 20.8826 | 20.6220 | 20.3935 | (87)    |      |
| Th 2  | 20.1606                   | 20.1703 | 20.1769 | 20.1998 | 20.1998 | 20.2162 | 20.2162 | 20.2195 | 20.2064 | 20.1801 | 20.1736 | 20.1606 | (88)    |      |
| util rest of house  | 0.9316                    | 0.8960  | 0.8202  | 0.6845  | 0.5392  | 0.3626  | 0.2880  | 0.2734  | 0.4283  | 0.6903  | 0.8654  | 0.9378  | (89)    |      |
| MIT 2   | 19.8536                   | 19.5816 | 19.8403 | 20.0797 | 20.1664 | 20.2125 | 20.2153 | 20.2189 | 20.1984 | 20.0786 | 19.7862 | 19.5205 | (90)    |      |
| Living area fraction  | FLA = Living area / (4) = |         |         |         |         |         |         |         |         |         |         | 0.3780  | (91)    |      |
| MIT   | 20.1526                   | 19.9126 | 20.1552 | 20.3795 | 20.4661 | 20.5080 | 20.5112 | 20.5136 | 20.4967 | 20.3825 | 20.1021 | 19.8505 | (92)    |      |
| Temperature adjustment  |                           |         |         |         |         |         |         |         |         |         |         | 0.0000  |         |      |
| adjusted MIT  | 20.1526                   | 19.9126 | 20.1552 | 20.3795 | 20.4661 | 20.5080 | 20.5112 | 20.5136 | 20.4967 | 20.3825 | 20.1021 | 19.8505 | (93)    |      |

## 8. Space heating requirement

|  |           |           |           |          |          |          |          |          |          |          |           |               |              |
|--|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|-----------|---------------|--------------|
| Utilisation  | Jan       | Feb       | Mar       | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec           |              |
| Useful gains   | 875.8812  | 939.9614  | 965.8533  | 912.8219 | 750.4728 | 530.7366 | 388.5255 | 360.2120 | 515.5059 | 711.4123 | 796.4355  | 826.4314      | (95)         |
| Ext temp.  | 6.6000    | 6.8000    | 8.0000    | 9.7000   | 12.1000  | 14.6000  | 16.2000  | 16.5000  | 14.8000  | 12.2000  | 9.5000    | 7.0000        | (96)         |
| Heat loss rate W   | 1318.4228 | 1259.4678 | 1157.5292 | 986.2926 | 772.6476 | 533.4953 | 389.3029 | 360.7803 | 521.4317 | 775.8508 | 1013.9841 | 1250.1242     | (97)         |
| Space heating kWh  | 329.2509  | 214.7083  | 142.6069  | 52.8989  | 16.4980  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 47.9422  | 156.6350  | 315.2275      | (98a)        |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |          |          |          |          |          |          |          |           | 1275.7677     |              |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000        | (98b)        |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |          |          |          |          |          |          |          |           | 0.0000        |              |
| Space heating kWh  | 329.2509  | 214.7083  | 142.6069  | 52.8989  | 16.4980  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 47.9422  | 156.6350  | 315.2275      | (98c)        |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |          |          |          |          |          |          |          |           | 1275.7677     |              |
| Space heating per m2   |           |           |           |          |          |          |          |          |          |          |           | (98c) / (4) = | 11.9097 (99) |



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

|   | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec       |                  |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------------|
| Fraction of space heat from secondary/supplementary system (Table 11)   |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (201)     |
| Fraction of space heat from main system(s)  |           |           |           |           |           |           |           |           |           |           |           |           | 1.0000 (202)     |
| Efficiency of main space heating system 1 (in %)  |           |           |           |           |           |           |           |           |           |           |           |           | 273.4178 (206)   |
| Efficiency of main space heating system 2 (in %)  |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (207)     |
| Efficiency of secondary/supplementary heating system, %   |           |           |           |           |           |           |           |           |           |           |           |           | 60.0000 (208)    |
| Space heating requirement   | 329.2509  | 214.7083  | 142.6069  | 52.8989   | 16.4980   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 47.9422   | 156.6350  | 315.2275  | (98)             |
| Space heating efficiency (main heating system 1)  | 273.4178  | 273.4178  | 273.4178  | 273.4178  | 273.4178  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 273.4178  | 273.4178  | 273.4178  | (210)            |
| Space heating fuel (main heating system)  | 120.4204  | 78.5276   | 52.1571   | 19.3473   | 6.0340    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 17.5344   | 57.2878   | 115.2915  | (211)            |
| Space heating efficiency (main heating system 2)  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (212)            |
| Space heating fuel (main heating system 2)  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (213)            |
| Space heating fuel (secondary)  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (215)            |
| Water heating requirement   | 276.4617  | 244.3527  | 259.1135  | 226.5340  | 218.7545  | 196.1904  | 192.8881  | 201.0199  | 203.7618  | 228.3346  | 244.1878  | 273.2617  | (64)             |
| Efficiency of water heater (217)m   | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | 283.6494  | (216)            |
| Fuel for water heating, kWh/month   | 97.4660   | 86.1460   | 91.3499   | 79.8641   | 77.1214   | 69.1665   | 68.0023   | 70.8692   | 71.8358   | 80.4989   | 86.0879   | 96.3378   | (219)            |
| Space cooling fuel requirement (221)m   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (221)            |
| Pumps and Fa  | 18.9800   | 17.1432   | 18.9800   | 18.3677   | 18.9800   | 18.3677   | 18.9800   | 18.3677   | 18.9800   | 18.3677   | 18.9800   | 18.3677   | (231)            |
| Lighting  | 30.1218   | 24.1648   | 21.7578   | 15.9407   | 12.3130   | 10.0598   | 11.2324   | 14.6002   | 18.9643   | 24.8821   | 28.1043   | 30.9590   | (232)            |
| Electricity generated by PVs (Appendix M) (negative quantity) (233a)m   | -74.2945  | -90.3908  | -123.2899 | -134.2640 | -137.4238 | -131.6439 | -124.5117 | -122.9169 | -113.2218 | -99.9545  | -76.9097  | -64.5519  | (233a)           |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m   | -212.5732 | -192.0016 | -212.5732 | -205.7160 | -212.5732 | -205.7160 | -212.5732 | -212.5732 | -205.7160 | -212.5732 | -205.7160 | -212.5732 | (234a)           |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (235a)           |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (235c)           |
| Electricity generated by PVs (Appendix M) (negative quantity) (233b)m   | -42.4419  | -71.1253  | -133.8851 | -202.5860 | -242.3430 | -268.1645 | -233.9382 | -222.0754 | -175.3705 | -107.7942 | -55.2008  | -33.7758  | (233b)           |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m   | -91.1028  | -82.2864  | -91.1028  | -88.1640  | -91.1028  | -88.1640  | -91.1028  | -91.1028  | -88.1640  | -91.1028  | -88.1640  | -91.1028  | (234b)           |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (235b)           |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (235d)           |
| Annual totals kWh/year  |           |           |           |           |           |           |           |           |           |           |           |           |                  |
| Space heating fuel - main system 1  |           |           |           |           |           |           |           |           |           |           |           |           | 466.6001 (211)   |
| Space heating fuel - main system 2  |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (213)     |
| Space heating fuel - secondary  |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (215)     |
| Efficiency of water heater  |           |           |           |           |           |           |           |           |           |           |           |           | 283.6494 (216)   |
| Water heating fuel used   |           |           |           |           |           |           |           |           |           |           |           |           | 974.7458 (219)   |
| Space cooling fuel  |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (221)     |
| Electricity for pumps and fans:<br>(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7125)<br>mechanical ventilation fans (SFP = 0.7125) |           |           |           |           |           |           |           |           |           |           |           |           | 223.4737 (230a)  |
| Total electricity for the above, kWh/year   |           |           |           |           |           |           |           |           |           |           |           |           | 223.4737 (231)   |
| Electricity for lighting (calculated in Appendix L)   |           |           |           |           |           |           |           |           |           |           |           |           | 243.1003 (232)   |
| Energy saving/generation technologies (Appendices M ,N and Q)   |           |           |           |           |           |           |           |           |           |           |           |           |                  |
| PV generation   |           |           |           |           |           |           |           |           |           |           |           |           | -3082.0742 (233) |
| Wind generation   |           |           |           |           |           |           |           |           |           |           |           |           | -3575.5408 (234) |
| Hydro-electric generation (Appendix N)  |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (235a)    |
| Electricity generated - Micro CHP (Appendix N)  |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (235)     |
| Appendix Q - special features   |           |           |           |           |           |           |           |           |           |           |           |           |                  |
| Energy saved or generated   |           |           |           |           |           |           |           |           |           |           |           |           | -0.0000 (236)    |
| Energy used   |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (237)     |
| Total delivered energy for all uses   |           |           |           |           |           |           |           |           |           |           |           |           | -4749.6950 (238) |

## 10a. Fuel costs - using BEDF prices (533)

|   | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |        |
|---|---------------|------------------|------------------|--------|
| Space heating - main system 1               | 466.6001      | 21.5100          | 100.3657         | (240)  |
| Total CO2 associated with community systems |               |                  | 0.0000           | (473)  |
| Water heating (other fuel)                  | 974.7458      | 21.5100          | 209.6678         | (247)  |
| Energy for instantaneous electric shower(s) | 0.0000        | 21.5100          | 0.0000           | (247a) |
| Pumps, fans and electric keep-hot           | 223.4737      | 21.5100          | 48.0692          | (249)  |
| Energy for lighting                         | 243.1003      | 21.5100          | 52.2909          | (250)  |
| Additional standing charges                 |               |                  | 0.0000           | (251)  |
| Energy saving/generation technologies       |               |                  |                  |        |
| PV Unit electricity used in dwelling        | -1293.3736    | 21.5100          | -278.2047        |        |
| PV Unit electricity exported                | -1788.7007    | 5.5900           | -99.9884         |        |
| Total                                       |               |                  | -378.1930        | (252)  |
| Wind Turbine electricity used in dwelling   | -2502.8785    | 21.5100          | -538.3692        |        |
| Wind Turbine electricity exported           | -1072.6622    | 5.5900           | -59.9618         |        |
| Total                                       |               |                  | -598.3310        | (252)  |
| Total energy cost                           |               |                  | -566.1304        | (255)  |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|   | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |       |
|---|-----------------|----------------------------|-----------------------|-------|
| Space heating - main system 1               | 466.6001        | 0.1577                     | 73.5638               | (261) |
| Total CO2 associated with community systems |                 |                            | 0.0000                | (373) |
| Water heating (other fuel)                  | 974.7458        | 0.1410                     | 137.4472              | (264) |
| Space and water heating                     |                 |                            | 211.0110              | (265) |
| Pumps, fans and electric keep-hot           | 223.4737        | 0.1387                     | 30.9986               | (267) |
| Energy for lighting                         | 243.1003        | 0.1443                     | 35.0869               | (268) |

# Full SAP Calculation Printout



|   |            |        |                 |
|---|------------|--------|-----------------|
| Energy saving/generation technologies     |            |        |                 |
| PV Unit electricity used in dwelling      | -1293.3736 | 0.1358 | -175.7026       |
| PV Unit electricity exported              | -1788.7007 | 0.1276 | -228.2701       |
| Total                                     |            |        | -403.9727 (269) |
| Wind Turbine electricity used in dwelling | -2502.8785 | 0.1387 | -347.1801       |
| Wind Turbine electricity exported         | -1072.6622 | 0.1387 | -148.7915       |
| Total                                     |            |        | -495.9716 (269) |
| Total CO2, kg/year                        |            |        | -622.8478 (272) |

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

|   | Energy<br>kWh/year | Primary energy factor<br>kg CO2/kWh | Primary energy<br>kWh/year |
|---|--------------------|-------------------------------------|----------------------------|
| Space heating - main system 1               | 466.6001           | 1.5836                              | 738.9180 (275)             |
| Total CO2 associated with community systems |                    |                                     | 0.0000 (473)               |
| Water heating (other fuel)                  | 974.7458           | 1.5214                              | 1482.9809 (278)            |
| Space and water heating                     |                    |                                     | 2221.8989 (279)            |
| Pumps, fans and electric keep-hot           | 223.4737           | 1.5128                              | 338.0711 (281)             |
| Energy for lighting                         | 243.1003           | 1.5338                              | 372.8753 (282)             |
| Energy saving/generation technologies       |                    |                                     |                            |
| PV Unit electricity used in dwelling        | -1293.3736         | 1.5021                              | -1942.8027                 |
| PV Unit electricity exported                | -1788.7007         | 0.4685                              | -838.0799                  |
| Total                                       |                    |                                     | -2780.8827 (283)           |
| Wind Turbine electricity used in dwelling   | -2502.8785         | 1.5128                              | -3786.3546                 |
| Wind Turbine electricity exported           | -1072.6622         | 0.5128                              | -550.0612                  |
| Total                                       |                    |                                     | -4336.4158 (283)           |
| Total Primary energy kWh/year               |                    |                                     | -4184.4532 (286)           |

# Full SAP Calculation Printout



|                                    |   |               |                |             |           |
|------------------------------------|---|---------------|----------------|-------------|-----------|
| Property Reference                 | Plot 2  |               | Issued on Date | 21/12/2023  |           |
| Assessment Reference               | 00001   | Prop Type Ref | Plot 2         |             |           |
| Property                           | Plot 2, Ryeland, Trevanna Cross, St Mawgan, Cornwall, TR8 4HB |               |                |             |           |
| SAP Rating                         | 98 A  | DER           | -0.36          | TER         | 10.47     |
| Environmental                      | 100 A   | % DER < TER   |                |             | 103.44    |
| CO <sub>2</sub> Emissions (t/year) | -0.17   | DFEE          | 37.83          | TFEE        | 44.67     |
| Compliance Check                   | See BREL  | % DFEE < TFEE |                |             | 15.32     |
| % DPER < TPER                      | 86.45   | DPER          | 7.44           | TPER        | 54.91     |
| Assessor Details                   | Mr. Matthew Fitzpatrick                                       |               |                | Assessor ID | 7601-0001 |
| Client                             |   |               |                |             |           |

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)  
CALCULATION OF ENERGY RATING

## 1. Overall dwelling characteristics

|  | Area (m <sup>2</sup> ) | Storey height (m)               | Volume (m <sup>3</sup> ) |
|--|------------------------|---------------------------------|--------------------------|
| Ground floor   | 74.7200 (1b)           | x 2.5000 (2b)                   | = 186.8000 (1b) - (3b)   |
| First floor  | 65.1500 (1c)           | x 2.3000 (2c)                   | = 149.8450 (1c) - (3c)   |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 139.8700               |                                 | (4)                      |
| Dwelling volume  |                        | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 336.6450 (5)           |

## 2. Ventilation rate

|   | m3 per hour                 |            |            |            |            |            |            |            |            |            |            |                 |
|---|-----------------------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|------------|-----------------|
| Number of open chimneys   | 0 * 80 =                    |            |            |            |            |            |            |            |            |            |            | 0.0000 (6a)     |
| Number of open flues  | 1 * 20 =                    |            |            |            |            |            |            |            |            |            |            | 20.0000 (6b)    |
| Number of chimneys / flues attached to closed fire  | 0 * 10 =                    |            |            |            |            |            |            |            |            |            |            | 0.0000 (6c)     |
| Number of flues attached to solid fuel boiler   | 0 * 20 =                    |            |            |            |            |            |            |            |            |            |            | 0.0000 (6d)     |
| Number of flues attached to other heater  | 0 * 35 =                    |            |            |            |            |            |            |            |            |            |            | 0.0000 (6e)     |
| Number of blocked chimneys  | 0 * 20 =                    |            |            |            |            |            |            |            |            |            |            | 0.0000 (6f)     |
| Number of intermittent extract fans   | 0 * 10 =                    |            |            |            |            |            |            |            |            |            |            | 0.0000 (7a)     |
| Number of passive vents   | 0 * 10 =                    |            |            |            |            |            |            |            |            |            |            | 0.0000 (7b)     |
| Number of flueless gas fires  | 0 * 40 =                    |            |            |            |            |            |            |            |            |            |            | 0.0000 (7c)     |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =      | 20.0000 / (5) =             |            |            |            |            |            |            |            |            |            |            | 0.0594 (8)      |
| Pressure test   |                             |            |            |            |            |            |            |            |            |            |            | Yes             |
| Pressure Test Method  |                             |            |            |            |            |            |            |            |            |            |            | Blower Door     |
| Measured/design AP50  |                             |            |            |            |            |            |            |            |            |            |            | 2.0000 (17)     |
| Infiltration rate   |                             |            |            |            |            |            |            |            |            |            |            | 0.1594 (18)     |
| Number of sides sheltered   |                             |            |            |            |            |            |            |            |            |            |            | 2 (19)          |
| Shelter factor  | (20) = 1 - [0.075 x (19)] = |            |            |            |            |            |            |            |            |            |            | 0.8500 (20)     |
| Infiltration rate adjusted to include shelter factor  | (21) = (18) x (20) =        |            |            |            |            |            |            |            |            |            |            | 0.1355 (21)     |
| Wind speed  | Jan 5.1000                  | Feb 5.0000 | Mar 4.9000 | Apr 4.4000 | May 4.3000 | Jun 3.8000 | Jul 3.8000 | Aug 3.7000 | Sep 4.0000 | Oct 4.3000 | Nov 4.5000 | Dec 4.7000 (22) |
| Wind factor   | 1.2750                      | 1.2500     | 1.2250     | 1.1000     | 1.0750     | 0.9500     | 0.9500     | 0.9250     | 1.0000     | 1.0750     | 1.1250     | 1.1750 (22a)    |
| Adj infilt rate   | 0.1728                      | 0.1694     | 0.1660     | 0.1490     | 0.1457     | 0.1287     | 0.1287     | 0.1253     | 0.1355     | 0.1457     | 0.1524     | 0.1592 (22b)    |
| Balanced mechanical ventilation with heat recovery  |                             |            |            |            |            |            |            |            |            |            |            |                 |
| If mechanical ventilation   |                             |            |            |            |            |            |            |            |            |            |            | 0.5000 (23a)    |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |                             |            |            |            |            |            |            |            |            |            |            | 0.5000 (23b)    |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |                             |            |            |            |            |            |            |            |            |            |            | 84.6000 (23c)   |
| Effective ac  | 0.2498                      | 0.2464     | 0.2430     | 0.2260     | 0.2227     | 0.2057     | 0.2057     | 0.2023     | 0.2125     | 0.2227     | 0.2294     | 0.2362 (25)     |

## 3. Heat losses and heat loss parameter

| Element   | Gross m <sup>2</sup> | Openings m <sup>2</sup> | NetArea m <sup>2</sup> | U-value W/m <sup>2</sup> K | A x U W/K | K-value kJ/m <sup>2</sup> K | A x K kJ/K       |
|---|----------------------|-------------------------|------------------------|----------------------------|-----------|-----------------------------|------------------|
| Front door  |                      |                         | 3.1500                 | 1.2000                     | 3.7800    |                             | (26)             |
| Utility Door  |                      |                         | 2.1200                 | 1.2000                     | 2.5440    |                             | (26a)            |
| Window (Uw = 0.80)  |                      |                         | 15.8000                | 0.7752                     | 12.2481   |                             | (27)             |
| Patio Door (Uw = 1.00)                                      |                      |                         | 12.6000                | 0.9615                     | 12.1154   |                             | (27)             |
| Front   |                      |                         | 1.4000                 | 1.0536                     | 1.4751    |                             | (27a)            |
| Side  |                      |                         | 0.7400                 | 1.0536                     | 0.7797    |                             | (27a)            |
| Rear  |                      |                         | 2.2100                 | 1.0536                     | 2.3285    |                             | (27a)            |
| Ground Floor  |                      |                         | 74.7200                | 0.1200                     | 8.9664    | 75.0000                     | 5604.0000 (28a)  |
| External Wall 1   | 165.1600             | 33.6700                 | 131.4900               | 0.1500                     | 19.7235   | 110.0000                    | 14463.9000 (29a) |
| Dormer Cheek  | 6.0000               |                         | 6.0000                 | 0.2100                     | 1.2600    | 9.0000                      | 54.0000 (29a)    |
| Cold Roof   | 23.8700              |                         | 23.8700                | 0.0900                     | 2.1483    | 9.0000                      | 214.8300 (30)    |
| Sloping Roof  | 65.8000              | 4.3500                  | 61.4500                | 0.1300                     | 7.9885    | 9.0000                      | 553.0500 (30)    |
| Dormer Roof   | 4.0100               |                         | 4.0100                 | 0.1000                     | 0.4010    | 9.0000                      | 36.0900 (30)     |
| Total net area of external elements Aum(A, m <sup>2</sup> ) |                      |                         | 339.5600               |                            |           |                             | (31)             |

# Full SAP Calculation Printout



|                                     |                      |         |         |                 |
|-------------------------------------|----------------------|---------|---------|-----------------|
| Fabric heat loss, W/K = Sum (A x U) | (26)...(30) + (32) = | 75.7585 |         | (33)            |
| GF                                  | 50.5300              |         | 9.0000  | 454.7700 (32c)  |
| FF                                  | 118.6900             |         | 9.0000  | 1068.2100 (32c) |
| GF Block                            | 54.2100              |         | 75.0000 | 4065.7500 (32c) |
| Internal Floor 1                    | 65.1500              |         | 18.0000 | 1172.7000 (32d) |
| Internal Ceiling 1                  | 65.1500              |         | 9.0000  | 586.3500 (32e)  |

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 28273.6500 (34)  
 Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 202.1423 (35)

|  |         |           |         |
|--|---------|-----------|---------|
| List of Thermal Bridges  |         |           |         |
|  | Length  | Psi-value | Total   |
| K1 Element   |         |           |         |
| E1 Steel lintel with perforated steel base plate                 | 19.3900 | 0.0500    | 0.9695  |
| E3 Sill  | 14.4200 | 0.0240    | 0.3461  |
| E4 Jamb  | 56.1000 | 0.0190    | 1.0659  |
| E5 Ground floor (normal)   | 37.6000 | 0.1170    | 4.3992  |
| E6 Intermediate floor within a dwelling                          | 34.0000 | 0.0010    | 0.0340  |
| E16 Corner (normal)  | 29.2000 | 0.0380    | 1.1096  |
| R1 Head of roof window   | 3.9500  | 0.2400    | 0.9480  |
| R2 Sill of roof window   | 3.9500  | 0.2400    | 0.9480  |
| R3 Jamb of roof window   | 11.0000 | 0.2400    | 2.6400  |
| E10 Eaves (insulation at ceiling level)                          | 5.2100  | 0.0730    | 0.3803  |
| E11 Eaves (insulation at rafter level)                           | 26.0000 | 0.0250    | 0.6500  |
| E12 Gable (insulation at ceiling level)                          | 8.0800  | 0.0960    | 0.7757  |
| E13 Gable (insulation at rafter level)                           | 15.8900 | 0.0600    | 0.9534  |
| R6 Flat ceiling  | 17.9300 | 0.0600    | 1.0758  |
| R7 Flat ceiling (inverted)                                       | 5.6700  | 0.0600    | 0.3402  |
| E17 Corner (inverted - internal area greater than external area) | 10.0000 | -0.0660   | -0.6600 |

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 15.9757 (36)  
 Point Thermal bridges (36a) = 0.0000  
 Total fabric heat loss (33) + (36) + (36a) = 91.7342 (37)

|   |          |          |          |          |          |          |          |          |          |          |          |               |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |          |          |          |          |          |          |          |          |          |          |               |
| (38)m   | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|   | 27.7466  | 27.3703  | 26.9939  | 25.1123  | 24.7360  | 22.8544  | 22.8544  | 22.4781  | 23.6070  | 24.7360  | 25.4887  | 26.2413 (38)  |
| Heat transfer coeff   | 119.4808 | 119.1044 | 118.7281 | 116.8465 | 116.4702 | 114.5886 | 114.5886 | 114.2122 | 115.3412 | 116.4702 | 117.2228 | 117.9755 (39) |
| Average = Sum(39)m / 12 =   |          |          |          |          |          |          |          |          |          |          |          | 116.7524      |
| HLP   | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|   | 0.8542   | 0.8515   | 0.8488   | 0.8354   | 0.8327   | 0.8193   | 0.8193   | 0.8166   | 0.8246   | 0.8327   | 0.8381   | 0.8435 (40)   |
| HLP (average)   |          |          |          |          |          |          |          |          |          |          |          | 0.8347        |
| Days in mont  | 31       | 28       | 31       | 30       | 31       | 30       | 31       | 31       | 30       | 31       | 30       | 31            |

#### 4. Water heating energy requirements (kWh/year)

|   |          |          |          |          |          |          |          |          |          |          |          |               |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Assumed occupancy 2.9168 (42)   |          |          |          |          |          |          |          |          |          |          |          |               |
| Hot water usage for mixer showers   |          |          |          |          |          |          |          |          |          |          |          |               |
|   | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|   | 73.1256  | 72.0267  | 70.4253  | 67.3614  | 65.1003  | 62.5787  | 61.1455  | 62.7347  | 64.4768  | 67.1842  | 70.3139  | 72.8454 (42a) |
| Hot water usage for baths   |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 31.5696  | 31.1008  | 30.4405  | 29.2232  | 28.3116  | 27.3008  | 26.7549  | 27.4105  | 28.1244  | 29.2059  | 30.4483  | 31.4629 (42b) |
| Hot water usage for other uses  |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 44.5013  | 42.8831  | 41.2649  | 39.6466  | 38.0284  | 36.4102  | 36.4102  | 38.0284  | 39.6466  | 41.2649  | 42.8831  | 44.5013 (42c) |
| Average daily hot water use (litres/day)  |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 149.1966 | 146.0105 | 142.1307 | 136.2312 | 131.4403 | 126.2897 | 124.3105 | 128.1736 | 132.2478 | 137.6550 | 143.6454 | 148.8097 (44) |
| Energy content (annual)   |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 236.2909 | 207.9171 | 218.4496 | 186.4937 | 176.9439 | 155.2880 | 150.3428 | 158.7057 | 163.0748 | 186.7965 | 204.6492 | 233.0000 (45) |
| Distribution loss (46)m = 0.15 x (45)m  |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 35.4436  | 31.1876  | 32.7674  | 27.9741  | 26.5416  | 23.2932  | 22.5514  | 23.8059  | 24.4612  | 28.0195  | 30.6974  | 34.9500 (46)  |
| Water storage loss:   |          |          |          |          |          |          |          |          |          |          |          |               |
| Store volume 250.0000 (47)  |          |          |          |          |          |          |          |          |          |          |          |               |
| a) If manufacturer declared loss factor is known (kWh/day):                                 |          |          |          |          |          |          |          |          |          |          |          |               |
| Temperature factor from Table 2b 1.4000 (48)  |          |          |          |          |          |          |          |          |          |          |          |               |
| Enter (49) or (54) in (55) 0.5400 (49)  |          |          |          |          |          |          |          |          |          |          |          |               |
| Total storage loss 0.7560 (55)  |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (56)  |
| If cylinder contains dedicated solar storage  |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (57)  |
| Primary loss  |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 23.2624  | 21.0112  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624 (59)  |
| Combi loss  |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (61)   |
| Total heat required for water heating calculated for each month                             |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 282.9893 | 250.0963 | 265.1480 | 231.6857 | 223.6423 | 200.4800 | 197.0412 | 205.4041 | 208.2668 | 233.4949 | 249.8412 | 279.6984 (62) |
| WWHRS   |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63a)  |
| PV diverter   |          |          |          |          |          |          |          |          |          |          |          |               |
|   | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000 (63b) |
| Solar input   |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63c)  |
| FGHRS   |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63d)  |
| Output from w/h   |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 282.9893 | 250.0963 | 265.1480 | 231.6857 | 223.6423 | 200.4800 | 197.0412 | 205.4041 | 208.2668 | 233.4949 | 249.8412 | 279.6984 (64) |
| Total per year (kWh/year) = Sum(64)m = 2827.7881 (64)                                       |          |          |          |          |          |          |          |          |          |          |          |               |
| Electric shower(s)  |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (64a)  |
| Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = 0.0000 (64a) |          |          |          |          |          |          |          |          |          |          |          |               |
| Heat gains from water heating, kWh/month  |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 115.9254 | 102.8758 | 109.9932 | 98.1627  | 96.1926  | 87.7869  | 87.3477  | 90.1284  | 90.3760  | 99.4686  | 104.1995 | 114.8312 (65) |

#### 5. Internal gains (see Table 5 and 5a)

|   |           |           |           |           |           |           |           |           |           |           |           |                |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| Metabolic gains (Table 5), Watts  |           |           |           |           |           |           |           |           |           |           |           |                |
| (66)m   | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec            |
|   | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 37.9350   | 33.6936   | 27.4014   | 20.7447   | 15.5069   | 13.0916   | 14.1459   | 18.3874   | 24.6795   | 31.3363   | 36.5740   | 38.9894 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 461.5883  | 466.3782  | 454.3079  | 428.6118  | 396.1751  | 365.6891  | 345.3226  | 340.5327  | 352.6030  | 378.2991  | 410.7359  | 441.2218 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179 (69)   |
| Pumps, fans   |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 |           |           |           |           |           |           |           |           |           |           |           |                |
|   | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 (71) |
| Water heating gains (Table 5)   |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 155.8138  | 153.0890  | 147.8403  | 136.3371  | 129.2911  | 121.9262  | 117.4028  | 121.1403  | 125.5222  | 133.6943  | 144.7215  | 154.3430 (72)  |
| Total internal gains  |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 769.0917  | 766.9153  | 743.3043  | 699.4482  | 654.7276  | 614.4614  | 590.6259  | 593.8150  | 616.5592  | 657.0843  | 705.7860  | 748.3088 (73)  |

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## 6. Solar gains

| [Jan]       |          |           | Area<br>m <sup>2</sup> | Solar flux<br>Table 6a<br>W/m <sup>2</sup> | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W   |           |           |          |               |
|-------------|----------|-----------|------------------------|--|-----------------------------------|------------------------------------|------------------------------|--------------|-----------|-----------|----------|---------------|
| North       |          |           | 5.9400                 | 10.6334                                    | 0.3900                            | 0.0000                             | 0.7700                       | 18.9677 (74) |           |           |          |               |
| East        |          |           | 3.7800                 | 19.6403                                    | 0.3900                            | 0.0000                             | 0.7700                       | 22.2943 (76) |           |           |          |               |
| South       |          |           | 6.0800                 | 46.7521                                    | 0.3900                            | 0.0000                             | 0.7700                       | 85.3610 (78) |           |           |          |               |
| North       |          |           | 12.6000                | 10.6334                                    | 0.5800                            | 0.7000                             | 0.7700                       | 37.6966 (74) |           |           |          |               |
| North       |          |           | 2.2100                 | 15.2954                                    | 0.6300                            | 0.7000                             | 1.0000                       | 13.4164 (82) |           |           |          |               |
| South       |          |           | 2.1400                 | 47.0123                                    | 0.6300                            | 0.7000                             | 1.0000                       | 39.9307 (82) |           |           |          |               |
| Solar gains | 217.6666 | 387.9408  | 582.2157               | 817.0540                                   | 1009.3419                         | 1045.2980                          | 989.6430                     | 838.3632     | 661.6690  | 442.0605  | 263.7014 | 184.4206 (83) |
| Total gains | 986.7583 | 1154.8561 | 1325.5200              | 1516.5022                                  | 1664.0695                         | 1659.7594                          | 1580.2689                    | 1432.1782    | 1278.2283 | 1099.1448 | 969.4873 | 932.7294 (84) |

## 7. Mean internal temperature (heating season)

| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |                           |         |         | 21.0000 (85) |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |                           |         |         |              |
|   | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep                       | Oct     | Nov     | Dec          |
| tau   | 65.7327 | 65.9404 | 66.1494 | 67.2146 | 67.4318 | 68.5391 | 68.5391 | 68.7649 | 68.0918                   | 67.4318 | 66.9988 | 66.5714      |
| alpha   | 5.3822  | 5.3960  | 5.4100  | 5.4810  | 5.4955  | 5.5693  | 5.5693  | 5.5843  | 5.5395                    | 5.4955  | 5.4666  | 5.4381       |
| util living area  | 0.9884  | 0.9732  | 0.9312  | 0.8146  | 0.6280  | 0.4392  | 0.3187  | 0.3660  | 0.6048                    | 0.8840  | 0.9754  | 0.9911 (86)  |
| Living  | 20.0165 | 20.2342 | 20.5296 | 20.8271 | 20.9631 | 20.9958 | 20.9994 | 20.9988 | 20.9779                   | 20.7678 | 20.3383 | 19.9777      |
| Non living  | 19.0584 | 19.3341 | 19.6995 | 20.0537 | 20.1949 | 20.2341 | 20.2365 | 20.2385 | 20.2169                   | 19.9987 | 19.4768 | 19.0163      |
| 24 / 16   | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0       | 0            |
| 24 / 9  | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0       | 0            |
| 16 / 9  | 28      | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0       | 10           |
| MIT   | 20.4969 | 20.2342 | 20.5296 | 20.8271 | 20.9631 | 20.9958 | 20.9994 | 20.9988 | 20.9779                   | 20.7678 | 20.3383 | 20.1207 (87) |
| Th 2  | 20.2066 | 20.2089 | 20.2112 | 20.2228 | 20.2251 | 20.2367 | 20.2367 | 20.2390 | 20.2320                   | 20.2251 | 20.2204 | 20.2158 (88) |
| util rest of house  | 0.9857  | 0.9670  | 0.9165  | 0.7827  | 0.5821  | 0.3879  | 0.2636  | 0.3059  | 0.5438                    | 0.8543  | 0.9688  | 0.9890 (89)  |
| MIT 2   | 19.7488 | 19.3341 | 19.6995 | 20.0537 | 20.1949 | 20.2341 | 20.2365 | 20.2385 | 20.2169                   | 19.9987 | 19.4768 | 19.2325 (90) |
| Living area fraction  |         |         |         |         |         |         |         |         | FLA = Living area / (4) = |         |         | 0.3319 (91)  |
| MIT   | 19.9971 | 19.6328 | 19.9750 | 20.3104 | 20.4498 | 20.4869 | 20.4897 | 20.4908 | 20.4694                   | 20.2539 | 19.7627 | 19.5273 (92) |
| Temperature adjustment  |         |         |         |         |         |         |         |         |                           |         |         | 0.0000       |
| adjusted MIT  | 19.9971 | 19.6328 | 19.9750 | 20.3104 | 20.4498 | 20.4869 | 20.4897 | 20.4908 | 20.4694                   | 20.2539 | 19.7627 | 19.5273 (93) |

## 8. Space heating requirement

|  | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct       | Nov       | Dec                        |
|--|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|-----------|----------------------------|
| Utilisation  | 0.9848    | 0.9616    | 0.9115    | 0.7865    | 0.5957    | 0.4048   | 0.2819   | 0.3258   | 0.5631   | 0.8555    | 0.9639    | 0.9866 (94)                |
| Useful gains   | 971.7611  | 1110.4965 | 1208.2497 | 1192.7295 | 991.2562  | 671.9034 | 445.4334 | 466.6173 | 719.7264 | 940.3052  | 934.4958  | 920.2133 (95)              |
| Ext temp.  | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000   | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000   | 7.1000    | 4.2000 (96)                |
| Heat loss rate W   | 1875.5012 | 1754.7420 | 1599.8602 | 1333.2604 | 1019.0945 | 674.5702 | 445.7113 | 467.2222 | 734.6591 | 1124.3938 | 1484.3534 | 1808.2417 (97)             |
| Space heating kWh  | 672.3826  | 432.9329  | 291.3582  | 101.1823  | 20.7117   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 136.9619  | 395.8975  | 660.6932 (98a)             |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |           |          |          |          |          |           |           | 2712.1203                  |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000 (98b)               |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |           |          |          |          |          |           |           | 0.0000                     |
| Space heating kWh  | 672.3826  | 432.9329  | 291.3582  | 101.1823  | 20.7117   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 136.9619  | 395.8975  | 660.6932 (98c)             |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |           |          |          |          |          |           |           | 2712.1203                  |
| Space heating per m <sup>2</sup>   |           |           |           |           |           |          |          |          |          |           |           | (98c) / (4) = 19.3903 (99) |

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

| Fraction of space heat from secondary/supplementary system (Table 11)   |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (201)    |
|---|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-----------------|
| Fraction of space heat from main system(s)                              |          |           |           |           |           |           |           |           |           |           |          | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)                        |          |           |           |           |           |           |           |           |           |           |          | 263.8845 (206)  |
| Efficiency of main space heating system 2 (in %)                        |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (207)    |
| Efficiency of secondary/supplementary heating system, %                 |          |           |           |           |           |           |           |           |           |           |          | 65.0000 (208)   |
|   | Jan      | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov      | Dec             |
| Space heating requirement   | 672.3826 | 432.9329  | 291.3582  | 101.1823  | 20.7117   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 136.9619  | 395.8975 | 660.6932 (98)   |
| Space heating efficiency (main heating system 1)                        | 263.8845 | 263.8845  | 263.8845  | 263.8845  | 263.8845  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 263.8845  | 263.8845 | 263.8845 (210)  |
| Space heating fuel (main heating system)                                | 254.8019 | 164.0616  | 110.4113  | 38.3434   | 7.8488    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 51.9022   | 150.0268 | 250.3721 (211)  |
| Space heating efficiency (main heating system 2)                        | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (212)    |
| Space heating fuel (main heating system 2)                              | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (213)    |
| Space heating fuel (secondary)  | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (215)    |
| Water heating   |          |           |           |           |           |           |           |           |           |           |          |                 |
| Water heating requirement   | 282.9893 | 250.0963  | 265.1480  | 231.6857  | 223.6423  | 200.4800  | 197.0412  | 205.4041  | 208.2668  | 233.4949  | 249.8412 | 279.6984 (64)   |
| Efficiency of water heater (217)m                                       | 279.3799 | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799 | 279.3799 (216)  |
| Fuel for water heating, kWh/month                                       | 101.2919 | 89.5184   | 94.9059   | 82.9285   | 80.0495   | 71.7589   | 70.5281   | 73.5214   | 74.5461   | 83.5761   | 89.4271  | 100.1140 (219)  |
| Space cooling fuel requirement (221)m                                   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (221)    |
| Pumps and Fa  | 23.9813  | 21.6606   | 23.9813   | 23.2078   | 23.9813   | 23.2078   | 23.9813   | 23.9813   | 23.2078   | 23.9813   | 23.2078  | 23.9813 (231)   |
| Lighting  | 33.2043  | 26.6377   | 23.9843   | 17.5719   | 13.5731   | 11.0893   | 12.3818   | 16.0943   | 20.9050   | 27.4284   | 30.9804  | 34.1272 (232)   |
| Electricity generated by PVs (Appendix M) (negative quantity) (233a)m   | -76.3859 | -105.0065 | -144.3409 | -152.3754 | -158.3411 | -146.0221 | -144.4593 | -137.8796 | -125.3946 | -113.0364 | -82.1747 | -66.2925 (233a) |
| Electricity generated by wind turbines (Appendix M) (negative quantity) |          |           |           |           |           |           |           |           |           |           |          |                 |

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|  |          |          |           |           |           |           |           |           |           |           |          |          |                  |
|--|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|------------------|
| (234a)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (234a)           |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| (235a)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (235a)           |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| (235c)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (235c)           |
| Electricity generated by PVs (Appendix M) (negative quantity)  |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| (233b)m  | -35.5410 | -75.4091 | -147.8428 | -220.2742 | -287.7708 | -287.2670 | -285.3080 | -246.7083 | -189.1101 | -113.3257 | -49.2895 | -28.2703 | (233b)           |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| (234b)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (234b)           |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| (235b)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (235b)           |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| (235d)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | (235d)           |
| Annual totals kWh/year   |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| Space heating fuel - main system 1   |          |          |           |           |           |           |           |           |           |           |          |          | 1027.7681 (211)  |
| Space heating fuel - main system 2   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000 (213)     |
| Space heating fuel - secondary   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000 (215)     |
| Efficiency of water heater   |          |          |           |           |           |           |           |           |           |           |          |          | 279.3799         |
| Water heating fuel used  |          |          |           |           |           |           |           |           |           |           |          |          | 1012.1660 (219)  |
| Space cooling fuel   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000 (221)     |
| Electricity for pumps and fans:  |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| (BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.6875)                           |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| mechanical ventilation fans (SFP = 0.6875)   |          |          |           |           |           |           |           |           |           |           |          |          | 282.3610 (230a)  |
| Total electricity for the above, kWh/year  |          |          |           |           |           |           |           |           |           |           |          |          | 282.3610 (231)   |
| Electricity for lighting (calculated in Appendix L)  |          |          |           |           |           |           |           |           |           |           |          |          | 267.9778 (232)   |
| Energy saving/generation technologies (Appendices M ,N and Q)  |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| PV generation  |          |          |           |           |           |           |           |           |           |           |          |          | -3417.8256 (233) |
| Wind generation  |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000 (234)     |
| Hydro-electric generation (Appendix N)   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000 (235a)    |
| Electricity generated - Micro CHP (Appendix N)   |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000 (235)     |
| Appendix Q - special features  |          |          |           |           |           |           |           |           |           |           |          |          |                  |
| Energy saved or generated  |          |          |           |           |           |           |           |           |           |           |          |          | -0.0000 (236)    |
| Energy used  |          |          |           |           |           |           |           |           |           |           |          |          | 0.0000 (237)     |
| Total delivered energy for all uses  |          |          |           |           |           |           |           |           |           |           |          |          | -827.5527 (238)  |

## 10a. Fuel costs - using Table 12 prices

|   | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |        |
|---|---------------|------------------|------------------|--------|
| Space heating - main system 1               | 1027.7681     | 16.4900          | 169.4790         | (240)  |
| Total CO2 associated with community systems |               |                  | 0.0000           | (473)  |
| Water heating (other fuel)                  | 1012.1660     | 16.4900          | 166.9062         | (247)  |
| Energy for instantaneous electric shower(s) | 0.0000        | 16.4900          | 0.0000           | (247a) |
| Pumps, fans and electric keep-hot           | 282.3610      | 16.4900          | 46.5613          | (249)  |
| Energy for lighting                         | 267.9778      | 16.4900          | 44.1895          | (250)  |
| Additional standing charges                 |               |                  | 0.0000           | (251)  |
| Energy saving/generation technologies       |               |                  |                  |        |
| PV Unit electricity used in dwelling        | -1451.7089    | 16.4900          | -239.3868        |        |
| PV Unit electricity exported                | -1966.1167    | 5.5900           | -109.9059        |        |
| Total                                       |               |                  | -349.2927        | (252)  |
| Total energy cost                           |               |                  | 77.8433          | (255)  |

## 11a. SAP rating - Individual heating systems

|                                  |   |         |       |
|----------------------------------|---|---------|-------|
| Energy cost deflator (Table 12): |   | 0.3600  | (256) |
| Energy cost factor (ECF)         | $[(255) \times (256)] / [(4) + 45.0] =$ | 0.1516  | (257) |
| SAP value                        |   | 97.5428 |       |
| SAP rating (Section 12)          |   | 98      | (258) |
| SAP band                         |   | A       |       |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|   | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |       |
|---|-----------------|----------------------------|-----------------------|-------|
| Space heating - main system 1               | 1027.7681       | 0.1573                     | 161.7180              | (261) |
| Total CO2 associated with community systems |                 |                            | 0.0000                | (373) |
| Water heating (other fuel)                  | 1012.1660       | 0.1410                     | 142.7366              | (264) |
| Space and water heating                     |                 |                            | 304.4546              | (265) |
| Pumps, fans and electric keep-hot           | 282.3610        | 0.1387                     | 39.1670               | (267) |
| Energy for lighting                         | 267.9778        | 0.1443                     | 38.6775               | (268) |
| Energy saving/generation technologies       |                 |                            |                       |       |
| PV Unit electricity used in dwelling        | -1451.7089      | 0.1356                     | -196.9121             |       |
| PV Unit electricity exported                | -1966.1167      | 0.1261                     | -247.9734             |       |
| Total                                       |                 |                            | -444.8855             | (269) |
| Total CO2, kg/year                          |                 |                            | -62.5864              | (272) |
| CO2 emissions per m2                        |                 |                            | -0.4500               | (273) |
| EI value                                    |                 |                            | 100.4536              |       |
| EI rating                                   |                 |                            | 100                   | (274) |
| EI band                                     |                 |                            | A                     |       |

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)  
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY

## 1. Overall dwelling characteristics

Area Storey height Volume

# Full SAP Calculation Printout



|  |              |   |             |   |  |
|--|--------------|---|-------------|---|--|
| Ground floor   | (m2)         | x | (m)         | = | (m3)   |
| First floor  | 74.7200 (1b) |   | 2.5000 (2b) |   | 186.8000 (1b) - (3b)                           |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 65.1500 (1c) | x | 2.3000 (2c) | = | 149.8450 (1c) - (3c)                           |
| Dwelling volume  | 139.8700     |   |             |   | (4)  |
|  |              |   |             |   | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = 336.6450 (5) |

## 2. Ventilation rate

|  |          |  |  |  |              |
|--|----------|--|--|--|--------------|
|  |          |  |  |  | m3 per hour  |
| Number of open chimneys                            | 0 * 80 = |  |  |  | 0.0000 (6a)  |
| Number of open flues                               | 1 * 20 = |  |  |  | 20.0000 (6b) |
| Number of chimneys / flues attached to closed fire | 0 * 10 = |  |  |  | 0.0000 (6c)  |
| Number of flues attached to solid fuel boiler      | 0 * 20 = |  |  |  | 0.0000 (6d)  |
| Number of flues attached to other heater           | 0 * 35 = |  |  |  | 0.0000 (6e)  |
| Number of blocked chimneys                         | 0 * 20 = |  |  |  | 0.0000 (6f)  |
| Number of intermittent extract fans                | 0 * 10 = |  |  |  | 0.0000 (7a)  |
| Number of passive vents                            | 0 * 10 = |  |  |  | 0.0000 (7b)  |
| Number of flueless gas fires                       | 0 * 40 = |  |  |  | 0.0000 (7c)  |

|  |   |                 |             |
|--|---|-----------------|-------------|
| Infiltration due to chimneys, flues and fans | = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 20.0000 / (5) = | 0.0594 (8)  |
| Pressure test                                |   |                 | Yes         |
| Pressure Test Method                         |   |                 | Blower Door |
| Measured/design AP50                         |   |                 | 2.0000 (17) |
| Infiltration rate                            |   |                 | 0.1594 (18) |
| Number of sides sheltered                    |   |                 | 2 (19)      |

|  |                             |             |
|--|-----------------------------|-------------|
| Shelter factor                                       | (20) = 1 - [0.075 x (19)] = | 0.8500 (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) =        | 0.1355 (21) |

|                 |        |        |        |        |        |        |        |        |        |        |        |              |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|                 | 6.3000 | 6.0000 | 5.8000 | 5.1000 | 5.1000 | 4.6000 | 4.6000 | 4.5000 | 4.9000 | 5.7000 | 5.9000 | 6.3000 (22)  |
| Wind factor     | 1.5750 | 1.5000 | 1.4500 | 1.2750 | 1.2750 | 1.1500 | 1.1500 | 1.1250 | 1.2250 | 1.4250 | 1.4750 | 1.5750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |

|   |        |        |        |        |        |        |        |        |        |        |        |               |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------------|
| Balanced mechanical ventilation with heat recovery  | 0.2134 | 0.2032 | 0.1965 | 0.1728 | 0.1728 | 0.1558 | 0.1558 | 0.1524 | 0.1660 | 0.1931 | 0.1999 | 0.2134 (22b)  |
| If mechanical ventilation   |        |        |        |        |        |        |        |        |        |        |        | 0.5000 (23a)  |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |        |        |        |        |        |        |        |        |        |        |        | 0.5000 (23b)  |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |        |        |        |        |        |        |        |        |        |        |        | 84.6000 (23c) |

|              |        |        |        |        |        |        |        |        |        |        |        |             |
|--------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| Effective ac | 0.2904 | 0.2802 | 0.2735 | 0.2498 | 0.2498 | 0.2328 | 0.2328 | 0.2294 | 0.2430 | 0.2701 | 0.2769 | 0.2904 (25) |
|--------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|

## 3. Heat losses and heat loss parameter

| Element   | Gross m2 | Openings m2 | NetArea m2 | U-value W/m2K | A x U W/K            | K-value kJ/m2K | A x K kJ/K   |
|---|----------|-------------|------------|---------------|----------------------|----------------|--|
| Front door  |          |             | 3.1500     | 1.2000        | 3.7800               |                | (26)   |
| Utility Door                                      |          |             | 2.1200     | 1.2000        | 2.5440               |                | (26a)  |
| Window (Uw = 0.80)                                |          |             | 15.8000    | 0.7752        | 12.2481              |                | (27)   |
| Patio Door (Uw = 1.00)                            |          |             | 12.6000    | 0.9615        | 12.1154              |                | (27)   |
| Front   |          |             | 1.4000     | 1.0536        | 1.4751               |                | (27a)  |
| Side  |          |             | 0.7400     | 1.0536        | 0.7797               |                | (27a)  |
| Rear  |          |             | 2.2100     | 1.0536        | 2.3285               |                | (27a)  |
| Ground Floor                                      |          |             | 74.7200    | 0.1200        | 8.9664               | 75.0000        | 5604.0000 (28a)                                      |
| External Wall 1                                   | 165.1600 | 33.6700     | 131.4900   | 0.1500        | 19.7235              | 110.0000       | 14463.9000 (29a)                                     |
| Dormer Cheek                                      | 6.0000   |             | 6.0000     | 0.2100        | 1.2600               | 9.0000         | 54.0000 (29a)  |
| Cold Roof   | 23.8700  |             | 23.8700    | 0.0900        | 2.1483               | 9.0000         | 214.8300 (30)  |
| Sloping Roof                                      | 65.8000  | 4.3500      | 61.4500    | 0.1300        | 7.9885               | 9.0000         | 553.0500 (30)  |
| Dormer Roof                                       | 4.0100   |             | 4.0100     | 0.1000        | 0.4010               | 9.0000         | 36.0900 (30)   |
| Total net area of external elements Aum (A, m2)   |          |             | 339.5600   |               |                      |                | (31)   |
| Fabric heat loss, W/K = Sum (A x U)               |          |             |            |               | (26)...(30) + (32) = | 75.7585        | (33)   |
| GF  |          |             | 50.5300    |               |                      | 9.0000         | 454.7700 (32c)                                       |
| FF  |          |             | 118.6900   |               |                      | 9.0000         | 1068.2100 (32c)                                      |
| GF Block  |          |             | 54.2100    |               |                      | 75.0000        | 4065.7500 (32c)                                      |
| Internal Floor 1                                  |          |             | 65.1500    |               |                      | 18.0000        | 1172.7000 (32d)                                      |
| Internal Ceiling 1                                |          |             | 65.1500    |               |                      | 9.0000         | 586.3500 (32e)                                       |
| Heat capacity Cm = Sum(A x k)                     |          |             |            |               |                      |                | (28)...(30) + (32) + (32a)...(32e) = 28273.6500 (34) |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K |          |             |            |               |                      |                | 202.1423 (35)  |

|  |  |  |  |         |           |         |                                    |
|--|--|--|--|---------|-----------|---------|------------------------------------|
| List of Thermal Bridges  |  |  |  |         |           |         |                                    |
| K1 Element   |  |  |  | Length  | Psi-value | Total   |                                    |
| E1 Steel lintel with perforated steel base plate                 |  |  |  | 19.3900 | 0.0500    | 0.9695  |                                    |
| E3 Sill  |  |  |  | 14.4200 | 0.0240    | 0.3461  |                                    |
| E4 Jamb  |  |  |  | 56.1000 | 0.0190    | 1.0659  |                                    |
| E5 Ground floor (normal)   |  |  |  | 37.6000 | 0.1170    | 4.3992  |                                    |
| E6 Intermediate floor within a dwelling                          |  |  |  | 34.0000 | 0.0010    | 0.0340  |                                    |
| E16 Corner (normal)  |  |  |  | 29.2000 | 0.0380    | 1.1096  |                                    |
| R1 Head of roof window   |  |  |  | 3.9500  | 0.2400    | 0.9480  |                                    |
| R2 Sill of roof window   |  |  |  | 3.9500  | 0.2400    | 0.9480  |                                    |
| R3 Jamb of roof window   |  |  |  | 11.0000 | 0.2400    | 2.6400  |                                    |
| E10 Eaves (insulation at ceiling level)                          |  |  |  | 5.2100  | 0.0730    | 0.3803  |                                    |
| E11 Eaves (insulation at rafter level)                           |  |  |  | 26.0000 | 0.0250    | 0.6500  |                                    |
| E12 Gable (insulation at ceiling level)                          |  |  |  | 8.0800  | 0.0960    | 0.7757  |                                    |
| E13 Gable (insulation at rafter level)                           |  |  |  | 15.8900 | 0.0600    | 0.9534  |                                    |
| R6 Flat ceiling  |  |  |  | 17.9300 | 0.0600    | 1.0758  |                                    |
| R7 Flat ceiling (inverted)                                       |  |  |  | 5.6700  | 0.0600    | 0.3402  |                                    |
| E17 Corner (inverted - internal area greater than external area) |  |  |  | 10.0000 | -0.0660   | -0.6600 |                                    |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)       |  |  |  |         |           |         | 15.9757 (36)                       |
| Point Thermal bridges  |  |  |  |         |           |         | (36a) = 0.0000                     |
| Total fabric heat loss   |  |  |  |         |           |         | (33) + (36) + (36a) = 91.7342 (37) |

|   |          |          |          |          |          |          |          |          |          |          |          |               |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |          |          |          |          |          |          |          |          |          |          |               |
| (38)m   | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|   | 32.2625  | 31.1335  | 30.3808  | 27.7466  | 27.7466  | 25.8650  | 25.8650  | 25.4887  | 26.9939  | 30.0045  | 30.7572  | 32.2625 (38)  |
| Heat transfer coeff   |          |          |          |          |          |          |          |          |          |          |          |               |
|   | 123.9966 | 122.8677 | 122.1150 | 119.4808 | 119.4808 | 117.5991 | 117.5991 | 117.2228 | 118.7281 | 121.7387 | 122.4913 | 123.9966 (39) |
| Average = Sum(39)m / 12 =   |          |          |          |          |          |          |          |          |          |          |          | 120.6097      |

|               |        |        |        |        |        |        |        |        |        |        |        |             |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| HLP           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec         |
|               | 0.8865 | 0.8784 | 0.8731 | 0.8542 | 0.8542 | 0.8408 | 0.8408 | 0.8381 | 0.8488 | 0.8704 | 0.8758 | 0.8865 (40) |
| HLP (average) |        |        |        |        |        |        |        |        |        |        |        | 0.8623      |
| Days in mont  | 31     | 28     | 31     | 30     | 31     | 30     | 31     | 31     | 30     | 31     | 30     | 31          |

# Full SAP Calculation Printout



## 4. Water heating energy requirements (kWh/year)

|  |          |          |          |          |          |          |          |          |          |          |          |                |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
| Assumed occupancy  |          |          |          |          |          |          |          |          |          |          |          | 2.9168 (42)    |
| Hot water usage for mixer showers  |          |          |          |          |          |          |          |          |          |          |          | 72.8454 (42a)  |
| Hot water usage for baths  |          |          |          |          |          |          |          |          |          |          |          | 31.4629 (42b)  |
| Hot water usage for other uses   |          |          |          |          |          |          |          |          |          |          |          | 44.5013 (42c)  |
| Average daily hot water use (litres/day)                                       |          |          |          |          |          |          |          |          |          |          |          | 137.1451 (43)  |
|  | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec            |
| Daily hot water use  | 149.1966 | 146.0105 | 142.1307 | 136.2312 | 131.4403 | 126.2897 | 124.3105 | 128.1736 | 132.2478 | 137.6550 | 143.6454 | 148.8097 (44)  |
| Energy content (annual)  | 236.2909 | 207.9171 | 218.4496 | 186.4937 | 176.9439 | 155.2880 | 150.3428 | 158.7057 | 163.0748 | 186.7965 | 204.6492 | 233.0000 (45)  |
| Distribution loss (46)m = 0.15 x (45)m   |          |          |          |          |          |          |          |          |          |          |          | 2277.9521      |
| Water storage loss:  |          |          |          |          |          |          |          |          |          |          |          |                |
| Store volume   |          |          |          |          |          |          |          |          |          |          |          | 250.0000 (47)  |
| a) If manufacturer declared loss factor is known (kWh/day):                    |          |          |          |          |          |          |          |          |          |          |          | 1.4000 (48)    |
| Temperature factor from Table 2b   |          |          |          |          |          |          |          |          |          |          |          | 0.5400 (49)    |
| Enter (49) or (54) in (55)   |          |          |          |          |          |          |          |          |          |          |          | 0.7560 (55)    |
| Total storage loss   |          |          |          |          |          |          |          |          |          |          |          |                |
| If cylinder contains dedicated solar storage                                   |          |          |          |          |          |          |          |          |          |          |          |                |
| Primary loss   |          |          |          |          |          |          |          |          |          |          |          | 23.2624 (57)   |
| Combi loss   |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (61)    |
| Total heat required for water heating calculated for each month                |          |          |          |          |          |          |          |          |          |          |          |                |
| WWHRs  |          |          |          |          |          |          |          |          |          |          |          | 279.6984 (62)  |
| PV diverter  |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63a)   |
| Solar input  |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63b)   |
| FGHRs  |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63c)   |
| Output from w/h  |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63d)   |
| Electric shower(s)   |          |          |          |          |          |          |          |          |          |          |          |                |
| Heat gains from water heating, kWh/month                                       |          |          |          |          |          |          |          |          |          |          |          |                |
| Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (64a)   |
| Total per year (kWh/year) = Sum(64)m =   |          |          |          |          |          |          |          |          |          |          |          | 2827.7881 (64) |

## 5. Internal gains (see Table 5 and 5a)

|   |          |          |          |          |          |          |          |          |          |          |          |               |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Metabolic gains (Table 5), Watts  |          |          |          |          |          |          |          |          |          |          |          |               |
| (66)m   | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |          |          |          |          |          |          |          |          |          |          |          |               |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |          |          |          |          |          |          |          |          |          |          |          |               |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |          |          |          |          |          |          |          |          |          |          |          |               |
| Pumps, fans   |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (70)   |
| Losses e.g. evaporation (negative values) (Table 5)                                 |          |          |          |          |          |          |          |          |          |          |          |               |
| Water heating gains (Table 5)   |          |          |          |          |          |          |          |          |          |          |          |               |
| Total internal gains  |          |          |          |          |          |          |          |          |          |          |          | 748.3088 (73) |

## 6. Solar gains

| [Jan]       | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W    |           |           |           |           |           |               |
|-------------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|---------------|-----------|-----------|-----------|-----------|-----------|---------------|
| North       | 5.9400     | 14.1804                        | 0.3900                            | 0.0000                             | 0.7700                       | 25.2947 (74)  |           |           |           |           |           |               |
| East        | 3.7800     | 26.5524                        | 0.3900                            | 0.0000                             | 0.7700                       | 30.1405 (76)  |           |           |           |           |           |               |
| South       | 6.8000     | 59.0235                        | 0.3900                            | 0.0000                             | 0.7700                       | 107.7666 (78) |           |           |           |           |           |               |
| North       | 12.6000    | 14.1804                        | 0.5800                            | 0.7000                             | 0.7700                       | 50.2711 (74)  |           |           |           |           |           |               |
| North       | 2.2100     | 20.0877                        | 0.6300                            | 0.7000                             | 1.0000                       | 17.6199 (82)  |           |           |           |           |           |               |
| South       | 2.1400     | 61.2906                        | 0.6300                            | 0.7000                             | 1.0000                       | 52.0581 (82)  |           |           |           |           |           |               |
| Solar gains | 283.1509   | 435.7500                       | 649.2897                          | 943.0921                           | 1098.7169                    | 1232.2035     | 1055.0505 | 961.4454  | 772.1870  | 510.8692  | 331.0326  | 238.8444 (83) |
| Total gains | 1052.2426  | 1202.6653                      | 1392.5940                         | 1642.5403                          | 1753.4445                    | 1846.6649     | 1645.6764 | 1555.2603 | 1388.7462 | 1167.9535 | 1036.8186 | 987.1532 (84) |

## 7. Mean internal temperature (heating season)

|   |         |         |         |         |         |         |         |         |         |         |         |              |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |         |         |              |
| tau   | 63.3388 | 63.9207 | 64.3147 | 65.7327 | 65.7327 | 66.7844 | 66.7844 | 66.9988 | 66.1494 | 64.5135 | 64.1171 | 63.3388      |
| alpha   | 5.2226  | 5.2614  | 5.2876  | 5.3822  | 5.3822  | 5.4523  | 5.4523  | 5.4666  | 5.4100  | 5.3009  | 5.2745  | 5.2226       |
| util living area  | 0.9730  | 0.9514  | 0.8906  | 0.7506  | 0.5896  | 0.4057  | 0.3423  | 0.3386  | 0.5219  | 0.8028  | 0.9386  | 0.9767 (86)  |
| Living  | 20.2709 | 20.4241 | 20.6665 | 20.8870 | 20.9715 | 20.9968 | 20.9989 | 20.9991 | 20.9890 | 20.8716 | 20.5821 | 20.2612      |
| Non living  | 19.3593 | 19.5528 | 19.8450 | 20.1015 | 20.1841 | 20.2162 | 20.2177 | 20.2201 | 20.2045 | 20.0815 | 19.7518 | 19.3482      |
| 24 / 16   | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0            |
| 24 / 9  | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0            |
| 16 / 9  | 28      | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 10           |
| MIT   | 20.6270 | 20.4241 | 20.6665 | 20.8870 | 20.9715 | 20.9968 | 20.9989 | 20.9991 | 20.9890 | 20.8716 | 20.5821 | 20.3646 (87) |
| Th 2  | 20.1790 | 20.1859 | 20.1905 | 20.2066 | 20.2066 | 20.2181 | 20.2181 | 20.2204 | 20.2112 | 20.1928 | 20.1882 | 20.1790 (88) |



# Full SAP Calculation Printout



|                        |         |         |         |         |         |         |         |         |                           |         |         |              |
|------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| util rest of house     | 0.9660  | 0.9397  | 0.8676  | 0.7126  | 0.5420  | 0.3569  | 0.2869  | 0.2802  | 0.4588                    | 0.7558  | 0.9209  | 0.9702 (89)  |
| MIT 2                  | 19.8522 | 19.5528 | 19.8450 | 20.1015 | 20.1841 | 20.2162 | 20.2177 | 20.2201 | 20.2045                   | 20.0815 | 19.7518 | 19.4979 (90) |
| Living area fraction   |         |         |         |         |         |         |         |         | FLA = Living area / (4) = |         |         | 0.3319 (91)  |
| MIT                    | 20.1094 | 19.8419 | 20.1176 | 20.3622 | 20.4454 | 20.4752 | 20.4770 | 20.4786 | 20.4649                   | 20.3437 | 20.0274 | 19.7855 (92) |
| Temperature adjustment |         |         |         |         |         |         |         |         |                           |         |         | 0.0000       |
| adjusted MIT           | 20.1094 | 19.8419 | 20.1176 | 20.3622 | 20.4454 | 20.4752 | 20.4770 | 20.4786 | 20.4649                   | 20.3437 | 20.0274 | 19.7855 (93) |

## 8. Space heating requirement

|  | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec                        |
|--|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------------------|
| Utilisation  | 0.9653    | 0.9339    | 0.8653    | 0.7204    | 0.5566   | 0.3730   | 0.3053   | 0.2996   | 0.4793   | 0.7653   | 0.9168    | 0.9665 (94)                |
| Useful gains   | 1015.7143 | 1123.2043 | 1205.0635 | 1183.2042 | 975.9247 | 688.8880 | 502.4218 | 465.9325 | 665.6513 | 893.7805 | 950.5596  | 954.0409 (95)              |
| Ext temp.  | 6.6000    | 6.8000    | 8.0000    | 9.7000    | 12.1000  | 14.6000  | 16.2000  | 16.5000  | 14.8000  | 12.2000  | 9.5000    | 7.0000 (96)                |
| Heat loss rate W   | 1675.1159 | 1602.4336 | 1479.7462 | 1273.9284 | 997.1152 | 690.9239 | 502.9669 | 466.3841 | 672.5831 | 991.4066 | 1289.5116 | 1585.3637 (97)             |
| Space heating kWh  | 490.5948  | 322.0421  | 204.3639  | 65.3214   | 15.7657  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 72.6338  | 244.0455  | 469.7042 (98a)             |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |          |          |          |          |          |          |           | 1884.4713                  |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000 (98b)               |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |          |          |          |          |          |          |           | 0.0000                     |
| Space heating kWh  | 490.5948  | 322.0421  | 204.3639  | 65.3214   | 15.7657  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 72.6338  | 244.0455  | 469.7042 (98c)             |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |          |          |          |          |          |          |           | 1884.4713                  |
| Space heating per m2   |           |           |           |           |          |          |          |          |          |          |           | (98c) / (4) = 13.4730 (99) |

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

|  |          |           |           |           |           |           |           |           |           |           |          |                  |
|--|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|------------------|
| Fraction of space heat from secondary/supplementary system (Table 11)  |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (201)     |
| Fraction of space heat from main system(s)   |          |           |           |           |           |           |           |           |           |           |          | 1.0000 (202)     |
| Efficiency of main space heating system 1 (in %)   |          |           |           |           |           |           |           |           |           |           |          | 262.4290 (206)   |
| Efficiency of main space heating system 2 (in %)   |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (207)     |
| Efficiency of secondary/supplementary heating system, %  |          |           |           |           |           |           |           |           |           |           |          | 65.0000 (208)    |
| Space heating requirement  | 490.5948 | 322.0421  | 204.3639  | 65.3214   | 15.7657   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 72.6338   | 244.0455 | 469.7042 (98)    |
| Space heating efficiency (main heating system 1)   | 262.4290 | 262.4290  | 262.4290  | 262.4290  | 262.4290  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 262.4290  | 262.4290 | 262.4290 (210)   |
| Space heating fuel (main heating system)   | 186.9438 | 122.7159  | 77.8740   | 24.8911   | 6.0076    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 27.6775   | 92.9948  | 178.9833 (211)   |
| Space heating efficiency (main heating system 2)   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (212)     |
| Space heating fuel (main heating system 2)   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (213)     |
| Space heating fuel (secondary)   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (215)     |
| Water heating  |          |           |           |           |           |           |           |           |           |           |          |                  |
| Water heating requirement  | 282.9893 | 250.0963  | 265.1480  | 231.6857  | 223.6423  | 200.4800  | 197.0412  | 205.4041  | 208.2668  | 233.4949  | 249.8412 | 279.6984 (64)    |
| Efficiency of water heater (217)m  | 278.7886 | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886 | 278.7886 (216)   |
| Fuel for water heating, kWh/month  | 101.5068 | 89.7082   | 95.1072   | 83.1044   | 80.2193   | 71.9111   | 70.6776   | 73.6774   | 74.7042   | 83.7534   | 89.6167  | 100.3263 (219)   |
| Space cooling fuel requirement (221)m  | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (221)     |
| Pumps and Fa   | 23.9813  | 21.6606   | 23.9813   | 23.2078   | 23.9813   | 23.2078   | 23.9813   | 23.9813   | 23.2078   | 23.9813   | 23.2078  | 23.9813 (231)    |
| Lighting   | 33.2043  | 26.6377   | 23.9843   | 17.5719   | 13.5731   | 11.0893   | 12.3818   | 16.0943   | 20.9050   | 27.4284   | 30.9804  | 34.1272 (232)    |
| Electricity generated by PVs (Appendix M) (negative quantity) (233a)m  | -92.2658 | -111.5443 | -150.1328 | -160.3569 | -162.6144 | -155.1555 | -147.1474 | -145.3716 | -134.5678 | -120.9085 | -94.7874 | -80.1804 (233a)  |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m                              | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (234a)    |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m                  | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (235a)    |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (235c)    |
| Electricity generated by PVs (Appendix M) (negative quantity) (233b)m  | -53.6548 | -90.3508  | -171.3359 | -260.7055 | -312.0941 | -344.6050 | -300.9150 | -285.8688 | -226.1726 | -138.7773 | -70.3508 | -42.7293 (233b)  |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m                              | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (234b)    |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m                  | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (235b)    |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (235d)    |
| Annual totals kWh/year   |          |           |           |           |           |           |           |           |           |           |          |                  |
| Space heating fuel - main system 1   |          |           |           |           |           |           |           |           |           |           |          | 718.0880 (211)   |
| Space heating fuel - main system 2   |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (213)     |
| Space heating fuel - secondary   |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (215)     |
| Efficiency of water heater   |          |           |           |           |           |           |           |           |           |           |          | 278.7886         |
| Water heating fuel used  |          |           |           |           |           |           |           |           |           |           |          | 1014.3126 (219)  |
| Space cooling fuel   |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (221)     |
| Electricity for pumps and fans:  |          |           |           |           |           |           |           |           |           |           |          |                  |
| (BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.6875)                                   |          |           |           |           |           |           |           |           |           |           |          |                  |
| mechanical ventilation fans (SFP = 0.6875)   |          |           |           |           |           |           |           |           |           |           |          | 282.3610 (230a)  |
| Total electricity for the above, kWh/year  |          |           |           |           |           |           |           |           |           |           |          | 282.3610 (231)   |
| Electricity for lighting (calculated in Appendix L)  |          |           |           |           |           |           |           |           |           |           |          | 267.9778 (232)   |
| Energy saving/generation technologies (Appendices M ,N and Q)  |          |           |           |           |           |           |           |           |           |           |          |                  |
| PV generation  |          |           |           |           |           |           |           |           |           |           |          | -3852.5928 (233) |
| Wind generation  |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (234)     |
| Hydro-electric generation (Appendix N)   |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (235a)    |
| Electricity generated - Micro CHP (Appendix N)   |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (235)     |
| Appendix Q - special features  |          |           |           |           |           |           |           |           |           |           |          |                  |
| Energy saved or generated  |          |           |           |           |           |           |           |           |           |           |          | -0.0000 (236)    |
| Energy used  |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (237)     |
| Total delivered energy for all uses  |          |           |           |           |           |           |           |           |           |           |          | -1569.8534 (238) |

## 10a. Fuel costs - using BEDF prices (533)

# Full SAP Calculation Printout



|   | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |
|---|---------------|------------------|------------------|
| Space heating - main system 1               | 718.0880      | 21.5100          | 154.4607 (240)   |
| Total CO2 associated with community systems |               |                  | 0.0000 (473)     |
| Water heating (other fuel)                  | 1014.3126     | 21.5100          | 218.1786 (247)   |
| Energy for instantaneous electric shower(s) | 0.0000        | 21.5100          | 0.0000 (247a)    |
| Pumps, fans and electric keep-hot           | 282.3610      | 21.5100          | 60.7358 (249)    |
| Energy for lighting                         | 267.9778      | 21.5100          | 57.6420 (250)    |
| Additional standing charges                 |               |                  | 0.0000 (251)     |
| Energy saving/generation technologies       |               |                  |                  |
| PV Unit electricity used in dwelling        | -1555.0328    | 21.5100          | -334.4875        |
| PV Unit electricity exported                | -2297.5600    | 5.5900           | -128.4336        |
| Total                                       |               |                  | -462.9212 (252)  |
| Total energy cost                           |               |                  | 28.0961 (255)    |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|   | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |
|---|-----------------|----------------------------|-----------------------|
| Space heating - main system 1               | 718.0880        | 0.1579                     | 113.3542 (261)        |
| Total CO2 associated with community systems |                 |                            | 0.0000 (373)          |
| Water heating (other fuel)                  | 1014.3126       | 0.1410                     | 143.0393 (264)        |
| Space and water heating                     |                 |                            | 256.3935 (265)        |
| Pumps, fans and electric keep-hot           | 282.3610        | 0.1387                     | 39.1670 (267)         |
| Energy for lighting                         | 267.9778        | 0.1443                     | 38.6775 (268)         |
| Energy saving/generation technologies       |                 |                            |                       |
| PV Unit electricity used in dwelling        | -1555.0328      | 0.1362                     | -211.7296             |
| PV Unit electricity exported                | -2297.5600      | 0.1275                     | -292.9502             |
| Total                                       |                 |                            | -504.6798 (269)       |
| Total CO2, kg/year                          |                 |                            | -170.4419 (272)       |

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

|   | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year |
|---|-----------------|----------------------------------|-------------------------|
| Space heating - main system 1               | 718.0880        | 1.5843                           | 1137.6956 (275)         |
| Total CO2 associated with community systems |                 |                                  | 0.0000 (473)            |
| Water heating (other fuel)                  | 1014.3126       | 1.5215                           | 1543.2262 (278)         |
| Space and water heating                     |                 |                                  | 2680.9217 (279)         |
| Pumps, fans and electric keep-hot           | 282.3610        | 1.5128                           | 427.1557 (281)          |
| Energy for lighting                         | 267.9778        | 1.5338                           | 411.0333 (282)          |
| Energy saving/generation technologies       |                 |                                  |                         |
| PV Unit electricity used in dwelling        | -1555.0328      | 1.5033                           | -2337.6520              |
| PV Unit electricity exported                | -2297.5600      | 0.4681                           | -1075.5565              |
| Total                                       |                 |                                  | -3413.2084 (283)        |
| Total Primary energy kWh/year               |                 |                                  | 105.9023 (286)          |

## SAP 10 EPC IMPROVEMENTS

00001

Current energy efficiency rating: A 98  
 Current environmental impact rating: A 100

N Solar water heating SAP increase too small  
 U Solar photovoltaic panels Already installed  
 V2 Wind turbine Recommended

Recommended measures:  
 V2 Wind turbine SAP change + 14.9 Cost change -£ 598 CO2 change -496 kg (291.0%)

Measures omitted - SAP change or cost saving too small:  
 N Solar water heating + 0.8 -£ 39 -26 kg (15.5%)

| Recommended measures | Typical annual savings            | Energy efficiency | Environmental impact |
|----------------------|-----------------------------------|-------------------|----------------------|
| Wind turbine         | £598 3.55 kg/m <sup>2</sup>       | A 112             | A 104                |
| <b>Total Savings</b> | <b>£598 3.55 kg/m<sup>2</sup></b> |                   |                      |

Potential energy efficiency rating: A 112  
 Potential environmental impact rating: A 104

Fuel prices for cost data on this page from database revision number 533 TEST (30 Nov 2023)  
 Recommendation texts revision number 6.1 (11 Jun 2019)

Typical heating and lighting costs of this home (per year, South West England):

|                                  | Current                | Potential              | Saving                |
|----------------------------------|------------------------|------------------------|-----------------------|
| Electricity                      | £491                   | £491                   | £0                    |
| Space heating                    | £215                   | £215                   | £0                    |
| Water heating                    | £218                   | £218                   | £0                    |
| Lighting                         | £58                    | £58                    | £0                    |
| Generated (PV)                   | -£463                  | -£463                  | £0                    |
| Generated (wind)                 | -£0                    | -£598                  | £598                  |
| Total cost of fuels              | £28                    | -£570                  | £598                  |
| Total cost of uses               | £28                    | -£570                  | £598                  |
| Delivered energy                 | -11 kWh/m <sup>2</sup> | -37 kWh/m <sup>2</sup> | 26 kWh/m <sup>2</sup> |
| Carbon dioxide emissions         | -0.2 tonnes            | -0.7 tonnes            | 0.5 tonnes            |
| CO2 emissions per m <sup>2</sup> | -1 kg/m <sup>2</sup>   | -5 kg/m <sup>2</sup>   | 4 kg/m <sup>2</sup>   |
| Primary energy                   | 1 kWh/m <sup>2</sup>   | -30 kWh/m <sup>2</sup> | 31 kWh/m <sup>2</sup> |

# Full SAP Calculation Printout



SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)  
CALCULATION OF ENERGY RATING FOR IMPROVED DWELLING

## 1. Overall dwelling characteristics

|  | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--|---------------------------|---------------------------------|-----------------------------|
| Ground floor   | 74.7200 (1b)              | x 2.5000 (2b)                   | = 186.8000 (1b) - (3b)      |
| First floor  | 65.1500 (1c)              | x 2.3000 (2c)                   | = 149.8450 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 139.8700                  |                                 | (4)                         |
| Dwelling volume  |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 336.6450 (5)              |

## 2. Ventilation rate

|  | Value                       | Reference    |
|--|-----------------------------|--------------|
| Number of open chimneys  | 0 * 80 =                    | 0.0000 (6a)  |
| Number of open flues   | 1 * 20 =                    | 20.0000 (6b) |
| Number of chimneys / flues attached to closed fire   | 0 * 10 =                    | 0.0000 (6c)  |
| Number of flues attached to solid fuel boiler  | 0 * 20 =                    | 0.0000 (6d)  |
| Number of flues attached to other heater   | 0 * 35 =                    | 0.0000 (6e)  |
| Number of blocked chimneys   | 0 * 20 =                    | 0.0000 (6f)  |
| Number of intermittent extract fans  | 0 * 10 =                    | 0.0000 (7a)  |
| Number of passive vents  | 0 * 10 =                    | 0.0000 (7b)  |
| Number of flueless gas fires   | 0 * 40 =                    | 0.0000 (7c)  |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) | 20.0000 / (5) =             | 0.0594 (8)   |
| Pressure test  | Yes                         |              |
| Pressure Test Method   | Blower Door                 |              |
| Measured/design AP50   | 2.0000                      | (17)         |
| Infiltration rate  | 0.1594                      | (18)         |
| Number of sides sheltered  | 2                           | (19)         |
| Shelter factor   | (20) = 1 - [0.075 x (19)] = | 0.8500 (20)  |
| Infiltration rate adjusted to include shelter factor   | (21) = (18) x (20) =        | 0.1355 (21)  |

|   | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec     |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| Wind speed  | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000  |
| Wind factor   | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750  |
| Adj infilt rate   | 0.1728 | 0.1694 | 0.1660 | 0.1490 | 0.1457 | 0.1287 | 0.1287 | 0.1253 | 0.1355 | 0.1457 | 0.1524 | 0.1592  |
| Balanced mechanical ventilation with heat recovery  |        |        |        |        |        |        |        |        |        |        |        | 0.5000  |
| If mechanical ventilation   |        |        |        |        |        |        |        |        |        |        |        | 0.5000  |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |        |        |        |        |        |        |        |        |        |        |        | 84.6000 |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |        |        |        |        |        |        |        |        |        |        |        | 0.2294  |
| Effective ac  | 0.2498 | 0.2464 | 0.2430 | 0.2260 | 0.2227 | 0.2057 | 0.2057 | 0.2023 | 0.2125 | 0.2227 | 0.2294 | 0.2362  |

## 3. Heat losses and heat loss parameter

| Element  | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K       | A x K<br>kJ/K |
|--|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------------|---------------|
| Front door   |                         |                            | 3.1500                    | 1.2000                        | 3.7800       |                                      | (26)          |
| Utility Door   |                         |                            | 2.1200                    | 1.2000                        | 2.5440       |                                      | (26a)         |
| Window (Uw = 0.80)   |                         |                            | 15.8000                   | 0.7752                        | 12.2481      |                                      | (27)          |
| Patio Door (Uw = 1.00)   |                         |                            | 12.6000                   | 0.9615                        | 12.1154      |                                      | (27)          |
| Front  |                         |                            | 1.4000                    | 1.0536                        | 1.4751       |                                      | (27a)         |
| Side   |                         |                            | 0.7400                    | 1.0536                        | 0.7797       |                                      | (27a)         |
| Rear   |                         |                            | 2.2100                    | 1.0536                        | 2.3285       |                                      | (27a)         |
| Ground Floor   |                         |                            | 74.7200                   | 0.1200                        | 8.9664       | 75.0000                              | 5604.0000     |
| External Wall 1  | 165.1600                | 33.6700                    | 131.4900                  | 0.1500                        | 19.7235      | 110.0000                             | 14463.9000    |
| Dormer Cheek   | 6.0000                  |                            | 6.0000                    | 0.2100                        | 1.2600       | 9.0000                               | 54.0000       |
| Cold Roof  | 23.8700                 |                            | 23.8700                   | 0.0900                        | 2.1483       | 9.0000                               | 214.8300      |
| Sloping Roof   | 65.8000                 | 4.3500                     | 61.4500                   | 0.1300                        | 7.9885       | 9.0000                               | 553.0500      |
| Dormer Roof  | 4.0100                  |                            | 4.0100                    | 0.1000                        | 0.4010       | 9.0000                               | 36.0900       |
| Total net area of external elements Aum(A, m <sup>2</sup> )    |                         |                            | 339.5600                  |                               |              |                                      | (31)          |
| Fabric heat loss, W/K = Sum (A x U)                            |                         |                            |                           | (26)...(30) + (32) =          | 75.7585      |                                      | (33)          |
| GF   |                         |                            | 50.5300                   |                               |              | 9.0000                               | 454.7700      |
| FF   |                         |                            | 118.6900                  |                               |              | 9.0000                               | 1068.2100     |
| GF Block   |                         |                            | 54.2100                   |                               |              | 75.0000                              | 4065.7500     |
| Internal Floor 1   |                         |                            | 65.1500                   |                               |              | 18.0000                              | 1172.7000     |
| Internal Ceiling 1   |                         |                            | 65.1500                   |                               |              | 9.0000                               | 586.3500      |
| Heat capacity Cm = Sum(A x k)                                  |                         |                            |                           |                               |              | (28)...(30) + (32) + (32a)...(32e) = | 28273.6500    |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K |                         |                            |                           |                               |              |                                      | 202.1423      |

| List of Thermal Bridges                          | Length  | Psi-value | Total  |
|--|---------|-----------|--------|
| K1 Element                                       |         |           |        |
| E1 Steel lintel with perforated steel base plate | 19.3900 | 0.0500    | 0.9695 |
| E3 Sill  | 14.4200 | 0.0240    | 0.3461 |
| E4 Jamb  | 56.1000 | 0.0190    | 1.0659 |
| E5 Ground floor (normal)                         | 37.6000 | 0.1170    | 4.3992 |
| E6 Intermediate floor within a dwelling          | 34.0000 | 0.0010    | 0.0340 |
| E16 Corner (normal)                              | 29.2000 | 0.0380    | 1.1096 |
| R1 Head of roof window                           | 3.9500  | 0.2400    | 0.9480 |
| R2 Sill of roof window                           | 3.9500  | 0.2400    | 0.9480 |
| R3 Jamb of roof window                           | 11.0000 | 0.2400    | 2.6400 |
| E10 Eaves (insulation at ceiling level)          | 5.2100  | 0.0730    | 0.3803 |
| E11 Eaves (insulation at rafter level)           | 26.0000 | 0.0250    | 0.6500 |
| E12 Gable (insulation at ceiling level)          | 8.0800  | 0.0960    | 0.7757 |
| E13 Gable (insulation at rafter level)           | 15.8900 | 0.0600    | 0.9534 |

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|  |         |         |                                    |
|--|---------|---------|------------------------------------|
| R6 Flat ceiling  | 17.9300 | 0.0600  | 1.0758                             |
| R7 Flat ceiling (inverted)                                       | 5.6700  | 0.0600  | 0.3402                             |
| E17 Corner (inverted - internal area greater than external area) | 10.0000 | -0.0660 | -0.6600                            |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)       |         |         | 15.9757 (36)                       |
| Point Thermal bridges  |         |         | 0.0000 (36a) =                     |
| Total fabric heat loss   |         |         | 91.7342 (37) (33) + (36) + (36a) = |

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

|       |         |         |         |         |         |         |         |         |         |         |         |              |
|-------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| (38)m | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
|       | 27.7466 | 27.3703 | 26.9939 | 25.1123 | 24.7360 | 22.8544 | 22.8544 | 22.4781 | 23.6070 | 24.7360 | 25.4887 | 26.2413 (38) |

Heat transfer coeff

|  |          |          |          |          |          |          |          |          |          |          |          |               |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
|  | 119.4808 | 119.1044 | 118.7281 | 116.8465 | 116.4702 | 114.5886 | 114.5886 | 114.2122 | 115.3412 | 116.4702 | 117.2228 | 117.9755 (39) |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|

Average = Sum(39)m / 12 =

|  |          |  |  |  |  |  |  |  |  |  |  |          |
|--|----------|--|--|--|--|--|--|--|--|--|--|----------|
|  | 116.7524 |  |  |  |  |  |  |  |  |  |  | 116.7524 |
|--|----------|--|--|--|--|--|--|--|--|--|--|----------|

|               |        |        |        |        |        |        |        |        |        |        |        |             |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| HLP           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec         |
|               | 0.8542 | 0.8515 | 0.8488 | 0.8354 | 0.8327 | 0.8193 | 0.8193 | 0.8166 | 0.8246 | 0.8327 | 0.8381 | 0.8435 (40) |
| HLP (average) |        |        |        |        |        |        |        |        |        |        |        | 0.8347      |
| Days in mont  | 31     | 28     | 31     | 30     | 31     | 30     | 31     | 31     | 30     | 31     | 30     | 31          |

## 4. Water heating energy requirements (kWh/year)

|   |          |          |          |          |          |          |          |          |          |          |          |               |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Assumed occupancy   |          |          |          |          |          |          |          |          |          |          |          | 2.9168 (42)   |
| Hot water usage for mixer showers   |          |          |          |          |          |          |          |          |          |          |          | 72.8454 (42a) |
| Hot water usage for baths   |          |          |          |          |          |          |          |          |          |          |          | 31.4629 (42b) |
| Hot water usage for other uses  |          |          |          |          |          |          |          |          |          |          |          | 44.5013 (42c) |
| Average daily hot water use (litres/day)  |          |          |          |          |          |          |          |          |          |          |          | 137.1451 (43) |
| Daily hot water use   | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|   | 149.1966 | 146.0105 | 142.1307 | 136.2312 | 131.4403 | 126.2897 | 124.3105 | 128.1736 | 132.2478 | 137.6550 | 143.6454 | 148.8097 (44) |
| Energy conte  | 236.2909 | 207.9171 | 218.4496 | 186.4937 | 176.9439 | 155.2880 | 150.3428 | 158.7057 | 163.0748 | 186.7965 | 204.6492 | 233.0000 (45) |
| Energy content (annual)   |          |          |          |          |          |          |          |          |          |          |          | 2277.9521     |
| Distribution loss (46)m = 0.15 x (45)m  |          |          |          |          |          |          |          |          |          |          |          | 34.9500 (46)  |
| Water storage loss:   |          |          |          |          |          |          |          |          |          |          |          | 250.0000 (47) |
| Store volume  |          |          |          |          |          |          |          |          |          |          |          | 1.4000 (48)   |
| a) If manufacturer declared loss factor is known (kWh/day):                     |          |          |          |          |          |          |          |          |          |          |          | 0.5400 (49)   |
| Temperature factor from Table 2b  |          |          |          |          |          |          |          |          |          |          |          | 0.7560 (55)   |
| Enter (49) or (54) in (55)  |          |          |          |          |          |          |          |          |          |          |          |               |
| Total storage loss  |          |          |          |          |          |          |          |          |          |          |          | 23.4360 (56)  |
| If cylinder contains dedicated solar storage                                    |          |          |          |          |          |          |          |          |          |          |          | 23.4360 (57)  |
| Primary loss  |          |          |          |          |          |          |          |          |          |          |          | 23.2624 (59)  |
| Combi loss  |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (61)   |
| Total heat required for water heating calculated for each month                 |          |          |          |          |          |          |          |          |          |          |          | 279.6984 (62) |
| WWHRS   |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63a)  |
| PV diverter   |          |          |          |          |          |          |          |          |          |          |          | -0.0000 (63b) |
| Solar input   |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63c)  |
| FGHRS   |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63d)  |
| Output from w/h   |          |          |          |          |          |          |          |          |          |          |          | 279.6984 (64) |
| Electric shower(s)  |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (64a)  |
| Total Energy used by instantaneous electric shower (s) (kWh/year) = Sum(64a)m = |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (64a)  |
| Heat gains from water heating, kWh/month  |          |          |          |          |          |          |          |          |          |          |          | 114.8312 (65) |

## 5. Internal gains (see Table 5 and 5a)

|   |          |          |          |          |          |          |          |          |          |          |          |                |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
| Metabolic gains (Table 5), Watts  | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec            |
| (66)m   | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 | 175.0102 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |          |          |          |          |          |          |          |          |          |          |          | 38.9894 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |          |          |          |          |          |          |          |          |          |          |          | 441.2218 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |          |          |          |          |          |          |          |          |          |          |          | 55.4179 (69)   |
| Pumps, fans   |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 |          |          |          |          |          |          |          |          |          |          |          | -116.6735 (71) |
| Water heating gains (Table 5)   |          |          |          |          |          |          |          |          |          |          |          | 154.3430 (72)  |
| Total internal gains  |          |          |          |          |          |          |          |          |          |          |          | 748.3088 (73)  |

## 6. Solar gains

|             |          |           |            |               |               |           |               |
|-------------|----------|-----------|------------|---------------|---------------|-----------|---------------|
| [Jan]       |          | Area      | Solar flux | g             | FF            | Access    | Gains         |
|             |          | m2        | Table 6a   | Specific data | Specific data | factor    | W             |
|             |          |           | W/m2       | or Table 6b   | or Table 6c   | Table 6d  |               |
| North       |          | 5.9400    | 10.6334    | 0.3900        | 0.0000        | 0.7700    | 18.9677 (74)  |
| East        |          | 3.7800    | 19.6403    | 0.3900        | 0.0000        | 0.7700    | 22.2943 (76)  |
| South       |          | 6.0800    | 46.7521    | 0.3900        | 0.0000        | 0.7700    | 85.3610 (78)  |
| North       |          | 12.6000   | 10.6334    | 0.5800        | 0.7000        | 0.7700    | 37.6966 (74)  |
| North       |          | 2.2100    | 15.2954    | 0.6300        | 0.7000        | 1.0000    | 13.4164 (82)  |
| South       |          | 2.1400    | 47.0123    | 0.6300        | 0.7000        | 1.0000    | 39.9307 (82)  |
| Solar gains | 217.6666 | 387.9408  | 582.2157   | 817.0540      | 1009.3419     | 1045.2980 | 989.6430      |
| Total gains | 986.7583 | 1154.8561 | 1325.5200  | 1516.5022     | 1664.0695     | 1659.7594 | 1580.2689     |
|             |          |           |            |               |               |           | 838.3632      |
|             |          |           |            |               |               |           | 661.6690      |
|             |          |           |            |               |               |           | 442.0605      |
|             |          |           |            |               |               |           | 263.7014      |
|             |          |           |            |               |               |           | 969.4873      |
|             |          |           |            |               |               |           | 184.4206 (83) |
|             |          |           |            |               |               |           | 932.7294 (84) |

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## 7. Mean internal temperature (heating season)

| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |                           |         | 21.0000 (85) |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|--------------|
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |                           |         |              |
|   | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct                       | Nov     | Dec          |
| tau   | 65.7327 | 65.9404 | 66.1494 | 67.2146 | 67.4318 | 68.5391 | 68.5391 | 68.7649 | 68.0918 | 67.4318                   | 66.9988 | 66.5714      |
| alpha   | 5.3822  | 5.3960  | 5.4100  | 5.4810  | 5.4955  | 5.5693  | 5.5693  | 5.5843  | 5.5395  | 5.4955                    | 5.4666  | 5.4381       |
| util living area  | 0.9884  | 0.9732  | 0.9312  | 0.8146  | 0.6280  | 0.4392  | 0.3187  | 0.3660  | 0.6048  | 0.8840                    | 0.9754  | 0.9911 (86)  |
| Living  | 20.0165 | 20.2342 | 20.5296 | 20.8271 | 20.9631 | 20.9958 | 20.9994 | 20.9988 | 20.9779 | 20.7678                   | 20.3383 | 19.9777      |
| Non living  | 19.0584 | 19.3341 | 19.6995 | 20.0537 | 20.1949 | 20.2341 | 20.2365 | 20.2385 | 20.2169 | 19.9987                   | 19.4768 | 19.0163      |
| 24 / 16   | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0            |
| 24 / 9  | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0            |
| 16 / 9  | 28      | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 10           |
| MIT   | 20.4969 | 20.2342 | 20.5296 | 20.8271 | 20.9631 | 20.9958 | 20.9994 | 20.9988 | 20.9779 | 20.7678                   | 20.3383 | 20.1207 (87) |
| Th 2  | 20.2066 | 20.2089 | 20.2112 | 20.2228 | 20.2251 | 20.2367 | 20.2367 | 20.2390 | 20.2320 | 20.2251                   | 20.2204 | 20.2158 (88) |
| util rest of house  | 0.9857  | 0.9670  | 0.9165  | 0.7827  | 0.5821  | 0.3879  | 0.2636  | 0.3059  | 0.5438  | 0.8543                    | 0.9688  | 0.9890 (89)  |
| MIT 2   | 19.7488 | 19.3341 | 19.6995 | 20.0537 | 20.1949 | 20.2341 | 20.2365 | 20.2385 | 20.2169 | 19.9987                   | 19.4768 | 19.2325 (90) |
| Living area fraction  |         |         |         |         |         |         |         |         |         | flA = Living area / (4) = |         | 0.3319 (91)  |
| MIT   | 19.9971 | 19.6328 | 19.9750 | 20.3104 | 20.4498 | 20.4869 | 20.4897 | 20.4908 | 20.4694 | 20.2539                   | 19.7627 | 19.5273 (92) |
| Temperature adjustment  |         |         |         |         |         |         |         |         |         |                           |         | 0.0000       |
| adjusted MIT  | 19.9971 | 19.6328 | 19.9750 | 20.3104 | 20.4498 | 20.4869 | 20.4897 | 20.4908 | 20.4694 | 20.2539                   | 19.7627 | 19.5273 (93) |

## 8. Space heating requirement

|  | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct       | Nov       | Dec                        |
|--|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|-----------|----------------------------|
| Utilisation  | 0.9848    | 0.9616    | 0.9115    | 0.7865    | 0.5957    | 0.4048   | 0.2819   | 0.3258   | 0.5631   | 0.8555    | 0.9639    | 0.9866 (94)                |
| Useful gains   | 971.7611  | 1110.4965 | 1208.2497 | 1192.7295 | 991.2562  | 671.9034 | 445.4334 | 466.6173 | 719.7264 | 940.3052  | 934.4958  | 920.2133 (95)              |
| Ext temp.  | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000   | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000   | 7.1000    | 4.2000 (96)                |
| Heat loss rate W   | 1875.5012 | 1754.7420 | 1599.8602 | 1333.2604 | 1019.0945 | 674.5702 | 445.7113 | 467.2222 | 734.6591 | 1124.3938 | 1484.3534 | 1808.2417 (97)             |
| Space heating kWh  | 672.3826  | 432.9329  | 291.3582  | 101.1823  | 20.7117   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 136.9619  | 395.8975  | 660.6932 (98a)             |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |           |          |          |          |          |           |           | 2712.1203                  |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000 (98b)               |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |           |          |          |          |          |           |           | 0.0000                     |
| Space heating kWh  | 672.3826  | 432.9329  | 291.3582  | 101.1823  | 20.7117   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 136.9619  | 395.8975  | 660.6932 (98c)             |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |           |          |          |          |          |           |           | 2712.1203                  |
| Space heating per m2   |           |           |           |           |           |          |          |          |          |           |           | (98c) / (4) = 19.3903 (99) |

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

|  |           |           |           |           |           |           |           |           |           |           |           |                  |
|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------------|
| Fraction of space heat from secondary/supplementary system (Table 11)                                |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (201)     |
| Fraction of space heat from main system(s)   |           |           |           |           |           |           |           |           |           |           |           | 1.0000 (202)     |
| Efficiency of main space heating system 1 (in %)   |           |           |           |           |           |           |           |           |           |           |           | 263.8845 (206)   |
| Efficiency of main space heating system 2 (in %)   |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (207)     |
| Efficiency of secondary/supplementary heating system, %  |           |           |           |           |           |           |           |           |           |           |           | 65.0000 (208)    |
| Space heating requirement  | 672.3826  | 432.9329  | 291.3582  | 101.1823  | 20.7117   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 136.9619  | 395.8975  | 660.6932 (98)    |
| Space heating efficiency (main heating system 1)   | 263.8845  | 263.8845  | 263.8845  | 263.8845  | 263.8845  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 263.8845  | 263.8845  | 263.8845 (210)   |
| Space heating fuel (main heating system)   | 254.8019  | 164.0616  | 110.4113  | 38.3434   | 7.8488    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 51.9022   | 150.0268  | 250.3721 (211)   |
| Space heating efficiency (main heating system 2)   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (212)     |
| Space heating fuel (main heating system 2)   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (213)     |
| Space heating fuel (secondary)   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (215)     |
| Water heating  |           |           |           |           |           |           |           |           |           |           |           |                  |
| Water heating requirement  | 282.9893  | 250.0963  | 265.1480  | 231.6857  | 223.6423  | 200.4800  | 197.0412  | 205.4041  | 208.2668  | 233.4949  | 249.8412  | 279.6984 (64)    |
| Efficiency of water heater   | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799 (216)   |
| Fuel for water heating, kWh/month  | 101.2919  | 89.5184   | 94.9059   | 82.9285   | 80.0495   | 71.7589   | 70.5281   | 73.5214   | 74.5461   | 83.5761   | 89.4271   | 100.1140 (219)   |
| Space cooling fuel requirement   |           |           |           |           |           |           |           |           |           |           |           |                  |
| (221)m   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (221)     |
| Pumps and Fa   | 23.9813   | 21.6606   | 23.9813   | 23.2078   | 23.9813   | 23.2078   | 23.9813   | 23.2078   | 23.2078   | 23.9813   | 23.2078   | 23.9813 (231)    |
| Lighting   | 33.2043   | 26.6377   | 23.9843   | 17.5719   | 13.5731   | 11.0893   | 12.3818   | 16.0943   | 20.9050   | 27.4284   | 30.9804   | 34.1272 (232)    |
| Electricity generated by PVs (Appendix M) (negative quantity)  | -76.3859  | -105.0065 | -144.3409 | -152.3754 | -158.3411 | -146.0221 | -144.4593 | -137.8796 | -125.3946 | -113.0364 | -82.1747  | -66.2925 (233a)  |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              | -212.5732 | -192.0016 | -212.5732 | -205.7160 | -212.5732 | -205.7160 | -212.5732 | -212.5732 | -205.7160 | -212.5732 | -205.7160 | -212.5732 (234a) |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (235a)    |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (235c)    |
| Electricity generated by PVs (Appendix M) (negative quantity)  | -35.5410  | -75.4091  | -147.8428 | -220.2742 | -287.7708 | -287.2670 | -285.3080 | -246.7083 | -189.1101 | -113.3257 | -49.2895  | -28.2703 (233b)  |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              | -91.1028  | -82.2864  | -91.1028  | -88.1640  | -91.1028  | -88.1640  | -91.1028  | -91.1028  | -88.1640  | -91.1028  | -88.1640  | -91.1028 (234b)  |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (235b)    |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (235d)    |
| Annual totals kWh/year   |           |           |           |           |           |           |           |           |           |           |           |                  |
| Space heating fuel - main system 1   |           |           |           |           |           |           |           |           |           |           |           | 1027.7681 (211)  |
| Space heating fuel - main system 2   |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (213)     |
| Space heating fuel - secondary   |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (215)     |
| Efficiency of water heater   |           |           |           |           |           |           |           |           |           |           |           | 279.3799         |
| Water heating fuel used  |           |           |           |           |           |           |           |           |           |           |           | 1012.1660 (219)  |
| Space cooling fuel   |           |           |           |           |           |           |           |           |           |           |           | 0.0000 (221)     |
| Electricity for pumps and fans:  |           |           |           |           |           |           |           |           |           |           |           |                  |
| (BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.6875)                           |           |           |           |           |           |           |           |           |           |           |           |                  |
| mechanical ventilation fans (SFP = 0.6875)   |           |           |           |           |           |           |           |           |           |           |           | 282.3610 (230a)  |

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|   |                  |
|---|------------------|
| Total electricity for the above, kWh/year                     | 282.3610 (231)   |
| Electricity for lighting (calculated in Appendix L)           | 267.9778 (232)   |
| Energy saving/generation technologies (Appendices M ,N and Q) |                  |
| PV generation   | -3417.8256 (233) |
| Wind generation   | -3575.5408 (234) |
| Hydro-electric generation (Appendix N)                        | 0.0000 (235a)    |
| Electricity generated - Micro CHP (Appendix N)                | 0.0000 (235)     |
| Appendix Q - special features                                 |                  |
| Energy saved or generated                                     | -0.0000 (236)    |
| Energy used   | 0.0000 (237)     |
| Total delivered energy for all uses                           | -4403.0934 (238) |

## 10a. Fuel costs - using Table 12 prices

|   | Fuel<br>kWh/year | Fuel price<br>p/kWh | Fuel cost<br>£/year |
|---|------------------|---------------------|---------------------|
| Space heating - main system 1               | 1027.7681        | 16.4900             | 169.4790 (240)      |
| Total CO2 associated with community systems |                  |                     | 0.0000 (473)        |
| Water heating (other fuel)                  | 1012.1660        | 16.4900             | 166.9062 (247)      |
| Energy for instantaneous electric shower(s) | 0.0000           | 16.4900             | 0.0000 (247a)       |
| Pumps, fans and electric keep-hot           | 282.3610         | 16.4900             | 46.5613 (249)       |
| Energy for lighting                         | 267.9778         | 16.4900             | 44.1895 (250)       |
| Additional standing charges                 |                  |                     | 0.0000 (251)        |
| Energy saving/generation technologies       |                  |                     |                     |
| PV Unit electricity used in dwelling        | -1451.7089       | 16.4900             | -239.3868           |
| PV Unit electricity exported                | -1966.1167       | 5.5900              | -109.9059           |
| Total                                       |                  |                     | -349.2927 (252)     |
| Wind Turbine electricity used in dwelling   | -2502.8785       | 16.4900             | -412.7247           |
| Wind Turbine electricity exported           | -1072.6622       | 5.5900              | -59.9618            |
| Total                                       |                  |                     | -472.6865 (252)     |
| Total energy cost                           |                  |                     | -394.8432 (255)     |

## 11a. SAP rating - Individual heating systems

|                                  |   |
|----------------------------------|---|
| Energy cost deflator (Table 12): | 0.3600 (256)  |
| Energy cost factor (ECF)         | $[(255) \times (256)] / [(4) + 45.0] = -0.7689 (257)$ |
| SAP value                        | 112.4636  |
| SAP rating (Section 12)          | 112 (258)   |
| SAP band                         | A   |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|   | Energy<br>kWh/year | Emission factor<br>kg CO2/kWh | Emissions<br>kg CO2/year |
|---|--------------------|-------------------------------|--------------------------|
| Space heating - main system 1               | 1027.7681          | 0.1573                        | 161.7180 (261)           |
| Total CO2 associated with community systems |                    |                               | 0.0000 (373)             |
| Water heating (other fuel)                  | 1012.1660          | 0.1410                        | 142.7366 (264)           |
| Space and water heating                     |                    |                               | 304.4546 (265)           |
| Pumps, fans and electric keep-hot           | 282.3610           | 0.1387                        | 39.1670 (267)            |
| Energy for lighting                         | 267.9778           | 0.1443                        | 38.6775 (268)            |
| Energy saving/generation technologies       |                    |                               |                          |
| PV Unit electricity used in dwelling        | -1451.7089         | 0.1356                        | -196.9121                |
| PV Unit electricity exported                | -1966.1167         | 0.1261                        | -247.9734                |
| Total                                       |                    |                               | -444.8855 (269)          |
| Wind Turbine electricity used in dwelling   | -2502.8785         | 0.1387                        | -347.1801                |
| Wind Turbine electricity exported           | -1072.6622         | 0.1387                        | -148.7915                |
| Total                                       |                    |                               | -495.9716 (269)          |
| Total CO2, kg/year                          |                    |                               | -558.5580 (272)          |
| CO2 emissions per m2                        |                    |                               | -3.9900 (273)            |
| EI value                                    |                    |                               | 104.0486                 |
| EI rating                                   |                    |                               | 104 (274)                |
| EI band                                     |                    |                               | A                        |

## SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING

### 1. Overall dwelling characteristics

|  | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--|---------------------------|---------------------------------|-----------------------------|
| Ground floor   | 74.7200 (1b)              | x 2.5000 (2b)                   | = 186.8000 (1b) - (3b)      |
| First floor  | 65.1500 (1c)              | x 2.3000 (2c)                   | = 149.8450 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 139.8700                  |                                 | (4)                         |
| Dwelling volume  |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 336.6450 (5)              |

### 2. Ventilation rate

|  | m <sup>3</sup> per hour |
|--|-------------------------|
| Number of open chimneys                            | 0 * 80 = 0.0000 (6a)    |
| Number of open flues                               | 1 * 20 = 20.0000 (6b)   |
| Number of chimneys / flues attached to closed fire | 0 * 10 = 0.0000 (6c)    |
| Number of flues attached to solid fuel boiler      | 0 * 20 = 0.0000 (6d)    |

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Number of flues attached to other heater 0 \* 35 = 0.0000 (6e)  
 Number of blocked chimneys 0 \* 20 = 0.0000 (6f)  
 Number of intermittent extract fans 0 \* 10 = 0.0000 (7a)  
 Number of passive vents 0 \* 10 = 0.0000 (7b)  
 Number of flueless gas fires 0 \* 40 = 0.0000 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = 20.0000 / (5) = 0.0594 (8)  
 Pressure test Yes  
 Pressure Test Method Blower Door  
 Measured/design AP50 2.0000 (17)  
 Infiltration rate 0.1594 (18)  
 Number of sides sheltered 2 (19)  
 Shelter factor (20) = 1 - [0.075 x (19)] = 0.8500 (20)  
 Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.1355 (21)

|   | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec     |
|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------|
| Wind speed  | 6.3000 | 6.0000 | 5.8000 | 5.1000 | 5.1000 | 4.6000 | 4.6000 | 4.5000 | 4.9000 | 5.7000 | 5.9000 | 6.3000  |
| Wind factor   | 1.5750 | 1.5000 | 1.4500 | 1.2750 | 1.2750 | 1.1500 | 1.1500 | 1.1250 | 1.2250 | 1.4250 | 1.4750 | 1.5750  |
| Adj infilt rate   | 0.2134 | 0.2032 | 0.1965 | 0.1728 | 0.1728 | 0.1558 | 0.1558 | 0.1524 | 0.1660 | 0.1931 | 0.1999 | 0.2134  |
| Balanced mechanical ventilation with heat recovery  |        |        |        |        |        |        |        |        |        |        |        |         |
| If mechanical ventilation   |        |        |        |        |        |        |        |        |        |        |        | 0.5000  |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |        |        |        |        |        |        |        |        |        |        |        | 0.5000  |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |        |        |        |        |        |        |        |        |        |        |        | 84.6000 |
| Effective ac  | 0.2904 | 0.2802 | 0.2735 | 0.2498 | 0.2498 | 0.2328 | 0.2328 | 0.2294 | 0.2430 | 0.2701 | 0.2769 | 0.2904  |

### 3. Heat losses and heat loss parameter

| Element  | Gross m2 | Openings m2 | NetArea m2 | U-value W/m2K | A x U W/K | K-value kJ/m2K | A x K kJ/K                    |
|--|----------|-------------|------------|---------------|-----------|----------------|-------------------------------|
| Front door   |          |             | 3.1500     | 1.2000        | 3.7800    |                | (26)                          |
| Utility Door   |          |             | 2.1200     | 1.2000        | 2.5440    |                | (26a)                         |
| Window (Uw = 0.80)   |          |             | 15.8000    | 0.7752        | 12.2481   |                | (27)                          |
| Patio Door (Uw = 1.00)   |          |             | 12.6000    | 0.9615        | 12.1154   |                | (27)                          |
| Front  |          |             | 1.4000     | 1.0536        | 1.4751    |                | (27a)                         |
| Side   |          |             | 0.7400     | 1.0536        | 0.7797    |                | (27a)                         |
| Rear   |          |             | 2.2100     | 1.0536        | 2.3285    |                | (27a)                         |
| Ground Floor   |          |             | 74.7200    | 0.1200        | 8.9664    | 75.0000        | 5604.0000                     |
| External Wall 1  | 165.1600 | 33.6700     | 131.4900   | 0.1500        | 19.7235   | 110.0000       | 14463.9000                    |
| Dormer Cheek   | 6.0000   |             | 6.0000     | 0.2100        | 1.2600    | 9.0000         | 54.0000                       |
| Cold Roof  | 23.8700  |             | 23.8700    | 0.0900        | 2.1483    | 9.0000         | 214.8300                      |
| Sloping Roof   | 65.8000  | 4.3500      | 61.4500    | 0.1300        | 7.9885    | 9.0000         | 553.0500                      |
| Dormer Roof  | 4.0100   |             | 4.0100     | 0.1000        | 0.4010    | 9.0000         | 36.0900                       |
| Total net area of external elements Aum(A, m2)                   |          |             | 339.5600   |               |           |                | (31)                          |
| Fabric heat loss, W/K = Sum (A x U)                              |          |             |            |               | 75.7585   |                | (32)                          |
| GF   |          |             | 50.5300    |               |           | 9.0000         | 454.7700                      |
| FF   |          |             | 118.6900   |               |           | 9.0000         | 1068.2100                     |
| GF Block   |          |             | 54.2100    |               |           | 75.0000        | 4065.7500                     |
| Internal Floor 1   |          |             | 65.1500    |               |           | 18.0000        | 1172.7000                     |
| Internal Ceiling 1   |          |             | 65.1500    |               |           | 9.0000         | 586.3500                      |
| Heat capacity Cm = Sum(A x k)                                    |          |             |            |               |           |                | (32a)...                      |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                |          |             |            |               |           |                | (32b)...                      |
| List of Thermal Bridges  |          |             |            |               |           |                | (32c)...                      |
| K1 Element   |          |             |            | Length        | Psi-value | Total          |                               |
| E1 Steel lintel with perforated steel base plate                 |          |             |            | 19.3900       | 0.0500    | 0.9695         |                               |
| E3 Sill  |          |             |            | 14.4200       | 0.0240    | 0.3461         |                               |
| E4 Jamb  |          |             |            | 56.1000       | 0.0190    | 1.0659         |                               |
| E5 Ground floor (normal)   |          |             |            | 37.6000       | 0.1170    | 4.3992         |                               |
| E6 Intermediate floor within a dwelling                          |          |             |            | 34.0000       | 0.0010    | 0.0340         |                               |
| E16 Corner (normal)  |          |             |            | 29.2000       | 0.0380    | 1.1096         |                               |
| R1 Head of roof window   |          |             |            | 3.9500        | 0.2400    | 0.9480         |                               |
| R2 Sill of roof window   |          |             |            | 3.9500        | 0.2400    | 0.9480         |                               |
| R3 Jamb of roof window   |          |             |            | 11.0000       | 0.2400    | 2.6400         |                               |
| E10 Eaves (insulation at ceiling level)                          |          |             |            | 5.2100        | 0.0730    | 0.3803         |                               |
| E11 Eaves (insulation at rafter level)                           |          |             |            | 26.0000       | 0.0250    | 0.6500         |                               |
| E12 Gable (insulation at ceiling level)                          |          |             |            | 8.0800        | 0.0960    | 0.7757         |                               |
| E13 Gable (insulation at rafter level)                           |          |             |            | 15.8900       | 0.0600    | 0.9534         |                               |
| R6 Flat ceiling  |          |             |            | 17.9300       | 0.0600    | 1.0758         |                               |
| R7 Flat ceiling (inverted)                                       |          |             |            | 5.6700        | 0.0600    | 0.3402         |                               |
| E17 Corner (inverted - internal area greater than external area) |          |             |            | 10.0000       | -0.0660   | -0.6600        |                               |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)       |          |             |            |               |           |                | 15.9757                       |
| Point Thermal bridges  |          |             |            |               |           |                | (36a) = 0.0000                |
| Total fabric heat loss   |          |             |            |               |           |                | (33) + (36) + (36a) = 91.7342 |

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) = 75.7585 (33)  
 Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K (26)...(30) + (32) + (32a)...(32e) = 28273.6500 (34)  
 List of Thermal Bridges (35) 202.1423 (35)  
 Total fabric heat loss (33) + (36) + (36a) = 91.7342 (37)

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

| (38)m                     | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec      |
|---------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| Heat transfer coeff       | 32.2625  | 31.1335  | 30.3808  | 27.7466  | 27.7466  | 25.8650  | 25.8650  | 25.4887  | 26.9939  | 30.0045  | 30.7572  | 32.2625  |
| Average = Sum(39)m / 12 = | 123.9966 | 122.8677 | 122.1150 | 119.4808 | 119.4808 | 117.5991 | 117.5991 | 117.2228 | 118.7281 | 121.7387 | 122.4913 | 123.9966 |

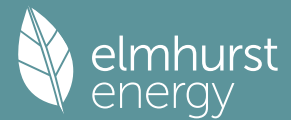
| HLP           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec    |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| HLP (average) | 0.8865 | 0.8784 | 0.8731 | 0.8542 | 0.8542 | 0.8408 | 0.8408 | 0.8381 | 0.8488 | 0.8704 | 0.8758 | 0.8865 |
| Days in mont  | 31     | 28     | 31     | 30     | 31     | 30     | 31     | 31     | 30     | 31     | 30     | 31     |

### 4. Water heating energy requirements (kWh/year)

| Assumed occupancy                        | 2.9168 (42) |         |         |         |         |         |         |         |         |         |         |          |
|--|-------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|----------|
| Hot water usage for mixer showers        | 73.1256     | 72.0267 | 70.4253 | 67.3614 | 65.1003 | 62.5787 | 61.1455 | 62.7347 | 64.4768 | 67.1842 | 70.3139 | 72.8454  |
| Hot water usage for baths                | 31.5696     | 31.1008 | 30.4405 | 29.2232 | 28.3116 | 27.3008 | 26.7549 | 27.4105 | 28.1244 | 29.2059 | 30.4483 | 31.4629  |
| Hot water usage for other uses           | 44.5013     | 42.8831 | 41.2649 | 39.6466 | 38.0284 | 36.4102 | 36.4102 | 38.0284 | 39.6466 | 41.2649 | 42.8831 | 44.5013  |
| Average daily hot water use (litres/day) |             |         |         |         |         |         |         |         |         |         |         | 137.1451 |

| Daily hot water use | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
|                     |     |     |     |     |     |     |     |     |     |     |     |     |

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|   |          |          |          |          |          |          |          |          |          |          |          |                              |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|------------------------------|
| Energy conte  | 149.1966 | 146.0105 | 142.1307 | 136.2312 | 131.4403 | 126.2897 | 124.3105 | 128.1736 | 132.2478 | 137.6550 | 143.6454 | 148.8097 (44)                |
| Energy content (annual)   | 236.2909 | 207.9171 | 218.4496 | 186.4937 | 176.9439 | 155.2880 | 150.3428 | 158.7057 | 163.0748 | 186.7965 | 204.6492 | 233.0000 (45)                |
| Distribution loss (46)m = 0.15 x (45)m                          |          |          |          |          |          |          |          |          |          |          |          | Total = Sum(45)m = 2277.9521 |
| Water storage loss:   | 35.4436  | 31.1876  | 32.7674  | 27.9741  | 26.5416  | 23.2932  | 22.5514  | 23.8059  | 24.4612  | 28.0195  | 30.6974  | 34.9500 (46)                 |
| Store volume  |          |          |          |          |          |          |          |          |          |          |          | 250.0000 (47)                |
| a) If manufacturer declared loss factor is known (kWh/day):     |          |          |          |          |          |          |          |          |          |          |          | 1.4000 (48)                  |
| Temperature factor from Table 2b                                |          |          |          |          |          |          |          |          |          |          |          | 0.5400 (49)                  |
| Enter (49) or (54) in (55)                                      |          |          |          |          |          |          |          |          |          |          |          | 0.7560 (55)                  |
| Total storage loss  | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (56)                 |
| If cylinder contains dedicated solar storage                    | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (57)                 |
| Primary loss  | 23.2624  | 21.0112  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624 (59)                 |
| Combi loss  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (61)                  |
| Total heat required for water heating calculated for each month | 282.9893 | 250.0963 | 265.1480 | 231.6857 | 223.6423 | 200.4800 | 197.0412 | 205.4041 | 208.2668 | 233.4949 | 249.8412 | 279.6984 (62)                |
| WWHRS   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63a)                 |
| PV diverter   | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000 (63b)                |
| Solar input   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63c)                 |
| FGHRS   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63d)                 |
| Output from w/h   | 282.9893 | 250.0963 | 265.1480 | 231.6857 | 223.6423 | 200.4800 | 197.0412 | 205.4041 | 208.2668 | 233.4949 | 249.8412 | 279.6984 (64)                |
| Electric shower(s)  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (64a)                 |
| Heat gains from water heating, kWh/month                        | 115.9254 | 102.8758 | 109.9932 | 98.1627  | 96.1926  | 87.7869  | 87.3477  | 90.1284  | 90.3760  | 99.4686  | 104.1995 | 114.8312 (65)                |

## 5. Internal gains (see Table 5 and 5a)

| Metabolic gains (Table 5), Watts  | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec            |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| (66)m   | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102  | 175.0102 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 37.9350   | 33.6936   | 27.4014   | 20.7447   | 15.5069   | 13.0916   | 14.1459   | 18.3874   | 24.6795   | 31.3363   | 36.5740   | 38.9894 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 461.5883  | 466.3782  | 454.3079  | 428.6118  | 396.1751  | 365.6891  | 345.3226  | 340.5327  | 352.6030  | 378.2991  | 410.7359  | 441.2218 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179   | 55.4179 (69)   |
| Pumps, fans   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 (71) |
| Water heating gains (Table 5)   | 155.8138  | 153.0890  | 147.8403  | 136.3371  | 129.2911  | 121.9262  | 117.4028  | 121.1403  | 125.5222  | 133.6943  | 144.7215  | 154.3430 (72)  |
| Total internal gains  | 769.0917  | 766.9153  | 743.3043  | 699.4482  | 654.7276  | 614.4614  | 590.6259  | 593.8150  | 616.5592  | 657.0843  | 705.7860  | 748.3088 (73)  |

## 6. Solar gains

| [Jan]       | Area m2   | Solar flux Table 6a W/m2 | Specific data or Table 6b | Specific data or Table 6c | FF        | Access factor Table 6d | Gains W   |           |           |           |           |               |
|-------------|-----------|--------------------------|---------------------------|---------------------------|-----------|------------------------|-----------|-----------|-----------|-----------|-----------|---------------|
| North       | 5.9400    | 14.1804                  | 0.3900                    | 0.0000                    | 0.7700    | 25.2947 (74)           |           |           |           |           |           |               |
| East        | 3.7800    | 26.5524                  | 0.3900                    | 0.0000                    | 0.7700    | 30.1405 (76)           |           |           |           |           |           |               |
| South       | 6.0800    | 59.0235                  | 0.3900                    | 0.0000                    | 0.7700    | 107.7666 (78)          |           |           |           |           |           |               |
| North       | 12.6000   | 14.1804                  | 0.5800                    | 0.7000                    | 0.7700    | 50.2711 (74)           |           |           |           |           |           |               |
| North       | 2.2100    | 20.0877                  | 0.6300                    | 0.7000                    | 1.0000    | 17.6199 (82)           |           |           |           |           |           |               |
| South       | 2.1400    | 61.2906                  | 0.6300                    | 0.7000                    | 1.0000    | 52.0581 (82)           |           |           |           |           |           |               |
| Solar gains | 283.1509  | 435.7500                 | 649.2897                  | 943.0921                  | 1098.7169 | 1232.2035              | 1055.0505 | 961.4454  | 772.1870  | 510.8692  | 331.0326  | 238.8444 (83) |
| Total gains | 1052.2426 | 1202.6653                | 1392.5940                 | 1642.5403                 | 1753.4445 | 1846.6649              | 1645.6764 | 1555.2603 | 1388.7462 | 1167.9535 | 1036.8186 | 987.1532 (84) |

## 7. Mean internal temperature (heating season)

| Temperature during heating periods in the living area from Table 9, Th1 (C) | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Utilisation factor for gains for living area, nil,m (see Table 9a)          | 63.3388 | 63.9207 | 64.3147 | 65.7327 | 65.7327 | 66.7844 | 66.7844 | 66.9988 | 66.1494 | 64.5135 | 64.1171 | 63.3388      |
| alpha   | 5.2226  | 5.2614  | 5.2876  | 5.3822  | 5.3822  | 5.4523  | 5.4523  | 5.4666  | 5.4100  | 5.3009  | 5.2745  | 5.2226       |
| util living area  | 0.9730  | 0.9514  | 0.8906  | 0.7506  | 0.5896  | 0.4057  | 0.3423  | 0.3386  | 0.5219  | 0.8028  | 0.9386  | 0.9767 (86)  |
| Living  | 20.2709 | 20.4241 | 20.6665 | 20.8870 | 20.9715 | 20.9968 | 20.9989 | 20.9991 | 20.9890 | 20.8716 | 20.5821 | 20.2612      |
| Non living  | 19.3593 | 19.5528 | 19.8450 | 20.1015 | 20.1841 | 20.2162 | 20.2177 | 20.2201 | 20.2045 | 20.0815 | 19.7518 | 19.3482      |
| 24 / 16   | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0            |
| 24 / 9  | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0            |
| 16 / 9  | 28      | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 10           |
| MIT   | 20.6270 | 20.4241 | 20.6665 | 20.8870 | 20.9715 | 20.9968 | 20.9989 | 20.9991 | 20.9890 | 20.8716 | 20.5821 | 20.3646 (87) |
| Th 2  | 20.1790 | 20.1859 | 20.1905 | 20.2066 | 20.2066 | 20.2181 | 20.2181 | 20.2204 | 20.2112 | 20.1928 | 20.1882 | 20.1790 (88) |
| util rest of house  | 0.9660  | 0.9397  | 0.8676  | 0.7126  | 0.5420  | 0.3569  | 0.2869  | 0.2802  | 0.4588  | 0.7558  | 0.9209  | 0.9702 (89)  |
| MIT 2   | 19.8522 | 19.5528 | 19.8450 | 20.1015 | 20.1841 | 20.2162 | 20.2177 | 20.2201 | 20.2045 | 20.0815 | 19.7518 | 19.4979 (90) |
| Living area fraction  | 20.1094 | 19.8419 | 20.1176 | 20.3622 | 20.4454 | 20.4752 | 20.4770 | 20.4786 | 20.4649 | 20.3437 | 20.0274 | 19.7855 (92) |
| Temperature adjustment  |         |         |         |         |         |         |         |         |         |         |         | 0.0000       |
| adjusted MIT  | 20.1094 | 19.8419 | 20.1176 | 20.3622 | 20.4454 | 20.4752 | 20.4770 | 20.4786 | 20.4649 | 20.3437 | 20.0274 | 19.7855 (93) |

## 8. Space heating requirement

| Utilisation  | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|--------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Useful gains | 1015.7143 | 1123.2043 | 1205.0635 | 1183.2042 | 975.9247 | 688.8880 | 502.4218 | 465.9325 | 665.6513 | 893.7805 | 950.5596 | 954.0409 (95) |
| Ext temp.    | 6.6000    | 6.8000    | 8.0000    | 9.7000    | 12.1000  | 14.6000  | 16.2000  | 16.5000  | 14.8000  | 12.2000  | 9.5000   | 7.0000 (96)   |



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|  |           |           |           |           |          |          |          |          |          |          |           |           |       |
|--|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------|
| Heat loss rate W   | 1675.1159 | 1602.4336 | 1479.7462 | 1273.9284 | 997.1152 | 690.9239 | 502.9669 | 466.3841 | 672.5831 | 991.4066 | 1289.5116 | 1585.3637 | (97)  |
| Space heating kWh  | 490.5948  | 322.0421  | 204.3639  | 65.3214   | 15.7657  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 72.6338  | 244.0455  | 469.7042  | (98a) |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |          |          |          |          |          |          |           | 1884.4713 |       |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | (98b) |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |          |          |          |          |          |          |           | 0.0000    |       |
| Space heating kWh  | 490.5948  | 322.0421  | 204.3639  | 65.3214   | 15.7657  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 72.6338  | 244.0455  | 469.7042  | (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |          |          |          |          |          |          |           | 1884.4713 |       |
| Space heating per m2   |           |           |           |           |          |          |          |          |          |          |           | 13.4730   | (99)  |

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

|  |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
|--|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------------|--------|
| Fraction of space heat from secondary/supplementary system (Table 11)                                |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000     | (201)  |
| Fraction of space heat from main system(s)   |           |           |           |           |           |           |           |           |           |           |           |           | 1.0000     | (202)  |
| Efficiency of main space heating system 1 (in %)   |           |           |           |           |           |           |           |           |           |           |           |           | 262.4290   | (206)  |
| Efficiency of main space heating system 2 (in %)   |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000     | (207)  |
| Efficiency of secondary/supplementary heating system, %  |           |           |           |           |           |           |           |           |           |           |           |           | 65.0000    | (208)  |
|  | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec       |            |        |
| Space heating requirement  | 490.5948  | 322.0421  | 204.3639  | 65.3214   | 15.7657   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 72.6338   | 244.0455  | 469.7042  | (98)       |        |
| Space heating efficiency (main heating system 1)   | 262.4290  | 262.4290  | 262.4290  | 262.4290  | 262.4290  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 262.4290  | 262.4290  | 262.4290  | (210)      |        |
| Space heating fuel (main heating system)   | 186.9438  | 122.7159  | 77.8740   | 24.8911   | 6.0076    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 27.6775   | 92.9948   | 178.9833  | (211)      |        |
| Space heating efficiency (main heating system 2)   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (212)      |        |
| Space heating fuel (main heating system 2)   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (213)      |        |
| Space heating fuel (secondary)   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (215)      |        |
| Water heating  |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| Water heating requirement  | 282.9893  | 250.0963  | 265.1480  | 231.6857  | 223.6423  | 200.4800  | 197.0412  | 205.4041  | 208.2668  | 233.4949  | 249.8412  | 279.6984  | (64)       |        |
| Efficiency of water heater   | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | 278.7886  | (216)      |        |
| Fuel for water heating, kWh/month  | 101.5068  | 89.7082   | 95.1072   | 83.1044   | 80.2193   | 71.9111   | 70.6776   | 73.6774   | 74.7042   | 83.7534   | 89.6167   | 100.3263  | (219)      |        |
| Space cooling fuel requirement   |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (221)m   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (221)      |        |
| Pumps and Fa   | 23.9813   | 21.6606   | 23.9813   | 23.2078   | 23.9813   | 23.2078   | 23.9813   | 23.2078   | 23.9813   | 23.2078   | 23.9813   | 23.2078   | (231)      |        |
| Lighting   | 33.2043   | 26.6377   | 23.9843   | 17.5719   | 13.5731   | 11.0893   | 12.3818   | 16.0943   | 20.9050   | 27.4284   | 30.9804   | 34.1272   | (232)      |        |
| Electricity generated by PVs (Appendix M) (negative quantity)  |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (233a)m  | -92.2658  | -111.5443 | -150.1328 | -160.3569 | -162.6144 | -155.1555 | -147.1474 | -145.3716 | -134.5678 | -120.9085 | -94.7874  | -80.1804  | (233a)     |        |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (234a)m  | -212.5732 | -192.0016 | -212.5732 | -205.7160 | -212.5732 | -205.7160 | -212.5732 | -212.5732 | -205.7160 | -212.5732 | -205.7160 | -212.5732 | (234a)     |        |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (235a)m  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (235a)     |        |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (235c)m  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (235c)     |        |
| Electricity generated by PVs (Appendix M) (negative quantity)  |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (233b)m  | -53.6548  | -90.3508  | -171.3359 | -260.7055 | -312.0941 | -344.6050 | -300.9150 | -285.8688 | -226.1726 | -138.7773 | -70.3508  | -42.7293  | (233b)     |        |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (234b)m  | -91.1028  | -82.2864  | -91.1028  | -88.1640  | -91.1028  | -88.1640  | -91.1028  | -91.1028  | -88.1640  | -91.1028  | -88.1640  | -91.1028  | (234b)     |        |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (235b)m  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (235b)     |        |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (235d)m  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (235d)     |        |
| Annual totals kWh/year   |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| Space heating fuel - main system 1   |           |           |           |           |           |           |           |           |           |           |           |           | 718.0880   | (211)  |
| Space heating fuel - main system 2   |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000     | (213)  |
| Space heating fuel - secondary   |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000     | (215)  |
| Efficiency of water heater   |           |           |           |           |           |           |           |           |           |           |           |           | 278.7886   |        |
| Water heating fuel used  |           |           |           |           |           |           |           |           |           |           |           |           | 1014.3126  | (219)  |
| Space cooling fuel   |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000     | (221)  |
| Electricity for pumps and fans:  |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| (BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.6875)                           |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| mechanical ventilation fans (SFP = 0.6875)   |           |           |           |           |           |           |           |           |           |           |           |           | 282.3610   | (230a) |
| Total electricity for the above, kWh/year  |           |           |           |           |           |           |           |           |           |           |           |           | 282.3610   | (231)  |
| Electricity for lighting (calculated in Appendix L)  |           |           |           |           |           |           |           |           |           |           |           |           | 267.9778   | (232)  |
| Energy saving/generation technologies (Appendices M ,N and Q)  |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| PV generation  |           |           |           |           |           |           |           |           |           |           |           |           | -3852.5928 | (233)  |
| Wind generation  |           |           |           |           |           |           |           |           |           |           |           |           | -3575.5408 | (234)  |
| Hydro-electric generation (Appendix N)   |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000     | (235a) |
| Electricity generated - Micro CHP (Appendix N)   |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000     | (235)  |
| Appendix Q - special features  |           |           |           |           |           |           |           |           |           |           |           |           |            |        |
| Energy saved or generated  |           |           |           |           |           |           |           |           |           |           |           |           | -0.0000    | (236)  |
| Energy used  |           |           |           |           |           |           |           |           |           |           |           |           | 0.0000     | (237)  |
| Total delivered energy for all uses  |           |           |           |           |           |           |           |           |           |           |           |           | -5145.3941 | (238)  |

## 10a. Fuel costs - using BEDF prices (533)

|   |               |                  |                  |        |
|---|---------------|------------------|------------------|--------|
|   | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |        |
| Space heating - main system 1               | 718.0880      | 21.5100          | 154.4607         | (240)  |
| Total CO2 associated with community systems |               |                  | 0.0000           | (473)  |
| Water heating (other fuel)                  | 1014.3126     | 21.5100          | 218.1786         | (247)  |
| Energy for instantaneous electric shower(s) | 0.0000        | 21.5100          | 0.0000           | (247a) |
| Pumps, fans and electric keep-hot           | 282.3610      | 21.5100          | 60.7358          | (249)  |
| Energy for lighting                         | 267.9778      | 21.5100          | 57.6420          | (250)  |
| Additional standing charges                 |               |                  | 0.0000           | (251)  |
| Energy saving/generation technologies       |               |                  |                  |        |
| PV Unit electricity used in dwelling        | -1555.0328    | 21.5100          | -334.4875        |        |
| PV Unit electricity exported                | -2297.5600    | 5.5900           | -128.4336        |        |
| Total                                       |               |                  | -462.9212        | (252)  |
| Wind Turbine electricity used in dwelling   | -2502.8785    | 21.5100          | -538.3692        |        |
| Wind Turbine electricity exported           | -1072.6622    | 5.5900           | -59.9618         |        |
| Total                                       |               |                  | -598.3310        | (252)  |
| Total energy cost                           |               |                  | -570.2349        | (255)  |

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 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP  
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|   | Energy<br>kWh/year | Emission factor<br>kg CO2/kWh | Emissions<br>kg CO2/year |
|---|--------------------|-------------------------------|--------------------------|
| Space heating - main system 1               | 718.0880           | 0.1579                        | 113.3542 (261)           |
| Total CO2 associated with community systems |                    |                               | 0.0000 (373)             |
| Water heating (other fuel)                  | 1014.3126          | 0.1410                        | 143.0393 (264)           |
| Space and water heating                     |                    |                               | 256.3935 (265)           |
| Pumps, fans and electric keep-hot           | 282.3610           | 0.1387                        | 39.1670 (267)            |
| Energy for lighting                         | 267.9778           | 0.1443                        | 38.6775 (268)            |
| Energy saving/generation technologies       |                    |                               |                          |
| PV Unit electricity used in dwelling        | -1555.0328         | 0.1362                        | -211.7296                |
| PV Unit electricity exported                | -2297.5600         | 0.1275                        | -292.9502                |
| Total                                       |                    |                               | -504.6798 (269)          |
| Wind Turbine electricity used in dwelling   | -2502.8785         | 0.1387                        | -347.1801                |
| Wind Turbine electricity exported           | -1072.6622         | 0.1387                        | -148.7915                |
| Total                                       |                    |                               | -495.9716 (269)          |
| Total CO2, kg/year                          |                    |                               | -666.4135 (272)          |

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

|   | Energy<br>kWh/year | Primary energy factor<br>kg CO2/kWh | Primary energy<br>kWh/year |
|---|--------------------|-------------------------------------|----------------------------|
| Space heating - main system 1               | 718.0880           | 1.5843                              | 1137.6956 (275)            |
| Total CO2 associated with community systems |                    |                                     | 0.0000 (473)               |
| Water heating (other fuel)                  | 1014.3126          | 1.5215                              | 1543.2262 (278)            |
| Space and water heating                     |                    |                                     | 2680.9217 (279)            |
| Pumps, fans and electric keep-hot           | 282.3610           | 1.5128                              | 427.1557 (281)             |
| Energy for lighting                         | 267.9778           | 1.5338                              | 411.0333 (282)             |
| Energy saving/generation technologies       |                    |                                     |                            |
| PV Unit electricity used in dwelling        | -1555.0328         | 1.5033                              | -2337.6520                 |
| PV Unit electricity exported                | -2297.5600         | 0.4681                              | -1075.5565                 |
| Total                                       |                    |                                     | -3413.2084 (283)           |
| Wind Turbine electricity used in dwelling   | -2502.8785         | 1.5128                              | -3786.3546                 |
| Wind Turbine electricity exported           | -1072.6622         | 0.5128                              | -550.0612                  |
| Total                                       |                    |                                     | -4336.4158 (283)           |
| Total Primary energy kWh/year               |                    |                                     | -4230.5135 (286)           |

# Full SAP Calculation Printout



|                                    |   |               |                |             |           |
|------------------------------------|---|---------------|----------------|-------------|-----------|
| Property Reference                 | Plot 1  |               | Issued on Date | 21/12/2023  |           |
| Assessment Reference               | 00001   | Prop Type Ref | Plot 1         |             |           |
| Property                           | Plot 1, Ryeland, Trevanna Cross, St Mawgan, Cornwall, TR8 4HB |               |                |             |           |
| SAP Rating                         | 98 A  | DER           | -0.39          | TER         | 11.24     |
| Environmental                      | 100 A   | % DER < TER   |                |             | 103.47    |
| CO <sub>2</sub> Emissions (t/year) | -0.13   | DFEE          | 33.21          | TFEE        | 41.23     |
| Compliance Check                   | See BREL  | % DFEE < TFEE |                |             | 19.46     |
| % DPER < TPER                      | 87.38   | DPER          | 7.41           | TPER        | 58.75     |
| Assessor Details                   | Mr. Matthew Fitzpatrick                                       |               |                | Assessor ID | 7601-0001 |
| Client                             |   |               |                |             |           |

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)  
 CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

### 1. Overall dwelling characteristics

|  | Area (m <sup>2</sup> ) | Storey height (m)               | Volume (m <sup>3</sup> ) |
|--|------------------------|---------------------------------|--------------------------|
| Ground floor   | 53.5600 (1b)           | x 2.5000 (2b)                   | = 133.9000 (1b) - (3b)   |
| First floor  | 53.5600 (1c)           | x 2.3000 (2c)                   | = 123.1880 (1c) - (3c)   |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 107.1200               |                                 | (4)                      |
| Dwelling volume  |                        | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 257.0880 (5)           |

### 2. Ventilation rate

|   | m3 per hour   |        |        |        |        |        |        |        |        |        |        |                 |            |
|---|---|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-----------------|------------|
| Number of open chimneys   | 0 * 80 =  |        |        |        |        |        |        |        |        |        |        | 0.0000 (6a)     |            |
| Number of open flues  | 1 * 20 =  |        |        |        |        |        |        |        |        |        |        | 20.0000 (6b)    |            |
| Number of chimneys / flues attached to closed fire  | 0 * 10 =  |        |        |        |        |        |        |        |        |        |        | 0.0000 (6c)     |            |
| Number of flues attached to solid fuel boiler   | 0 * 20 =  |        |        |        |        |        |        |        |        |        |        | 0.0000 (6d)     |            |
| Number of flues attached to other heater  | 0 * 35 =  |        |        |        |        |        |        |        |        |        |        | 0.0000 (6e)     |            |
| Number of blocked chimneys  | 0 * 20 =  |        |        |        |        |        |        |        |        |        |        | 0.0000 (6f)     |            |
| Number of intermittent extract fans   | 0 * 10 =  |        |        |        |        |        |        |        |        |        |        | 0.0000 (7a)     |            |
| Number of passive vents   | 0 * 10 =  |        |        |        |        |        |        |        |        |        |        | 0.0000 (7b)     |            |
| Number of flueless gas fires  | 0 * 40 =  |        |        |        |        |        |        |        |        |        |        | 0.0000 (7c)     |            |
| Infiltration due to chimneys, flues and fans  | = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = |        |        |        |        |        |        |        |        |        |        | 20.0000 / (5) = | 0.0778 (8) |
| Pressure test   |   |        |        |        |        |        |        |        |        |        |        | Yes             |            |
| Pressure Test Method  |   |        |        |        |        |        |        |        |        |        |        | Blower Door     |            |
| Measured/design AP50  |   |        |        |        |        |        |        |        |        |        |        | 3.0000 (17)     |            |
| Infiltration rate   |   |        |        |        |        |        |        |        |        |        |        | 0.2278 (18)     |            |
| Number of sides sheltered   |   |        |        |        |        |        |        |        |        |        |        | 2 (19)          |            |
| Shelter factor  | (20) = 1 - [0.075 x (19)] =                           |        |        |        |        |        |        |        |        |        |        | 0.8500 (20)     |            |
| Infiltration rate adjusted to include shelter factor  | (21) = (18) x (20) =                                  |        |        |        |        |        |        |        |        |        |        | 0.1936 (21)     |            |
| Wind speed  | Jan   | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec             |            |
| Wind factor   | 5.1000  | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)     |            |
| Adj infilt rate   | 1.2750  | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a)    |            |
| Balanced mechanical ventilation with heat recovery  | 0.2469  | 0.2420 | 0.2372 | 0.2130 | 0.2081 | 0.1839 | 0.1839 | 0.1791 | 0.1936 | 0.2081 | 0.2178 | 0.2275 (22b)    |            |
| If mechanical ventilation   |   |        |        |        |        |        |        |        |        |        |        | 0.5000 (23a)    |            |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |   |        |        |        |        |        |        |        |        |        |        | 0.5000 (23b)    |            |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |   |        |        |        |        |        |        |        |        |        |        | 84.6000 (23c)   |            |
| Effective ac  | 0.3239  | 0.3190 | 0.3142 | 0.2900 | 0.2851 | 0.2609 | 0.2609 | 0.2561 | 0.2706 | 0.2851 | 0.2948 | 0.3045 (25)     |            |

### 3. Heat losses and heat loss parameter

| Element   | Gross m <sup>2</sup> | Openings m <sup>2</sup> | NetArea m <sup>2</sup> | U-value W/m <sup>2</sup> K | A x U W/K | K-value kJ/m <sup>2</sup> K | A x K kJ/K       |
|---|----------------------|-------------------------|------------------------|----------------------------|-----------|-----------------------------|------------------|
| Front door  |                      |                         | 2.1200                 | 1.5000                     | 3.1800    |                             | (26)             |
| Utility Door  |                      |                         | 2.1200                 | 1.2000                     | 2.5440    |                             | (26a)            |
| Window (Uw = 0.80)  |                      |                         | 11.2200                | 0.7752                     | 8.6977    |                             | (27)             |
| French Door (Uw = 1.00)                                     |                      |                         | 5.0400                 | 0.9615                     | 4.8462    |                             | (27)             |
| Front   |                      |                         | 1.4000                 | 1.0536                     | 1.4751    |                             | (27a)            |
| Ground Floor  |                      |                         | 53.5600                | 0.1200                     | 6.4272    | 75.0000                     | 4017.0000 (28a)  |
| External Wall 1   | 128.6600             | 20.5000                 | 108.1600               | 0.1500                     | 16.2240   | 110.0000                    | 11897.6000 (29a) |
| Dormer Cheek  | 14.6200              |                         | 14.6200                | 0.2100                     | 3.0702    | 9.0000                      | 131.5800 (29a)   |
| Cold Roof   | 32.1100              |                         | 32.1100                | 0.0900                     | 2.8899    | 9.0000                      | 288.9900 (30)    |
| Sloping Roof  | 15.7200              | 1.4000                  | 14.3200                | 0.1300                     | 1.8616    | 9.0000                      | 128.8800 (30)    |
| Dormer Roof   | 10.9200              |                         | 10.9200                | 0.1000                     | 1.0920    | 9.0000                      | 98.2800 (30)     |
| Total net area of external elements Aum(A, m <sup>2</sup> ) |                      |                         | 255.5900               |                            |           |                             | (31)             |
| Fabric heat loss, W/K = Sum (A x U)                         |                      |                         |                        | (26)...(30) + (32) =       | 52.3078   |                             | (33)             |
| GF  |                      |                         | 68.1300                |                            |           | 9.0000                      | 613.1700 (32c)   |

# Full SAP Calculation Printout



|                    |         |         |                |
|--------------------|---------|---------|----------------|
| FF                 | 90.7800 | 9.0000  | 817.0200 (32c) |
| Internal Floor 1   | 53.5600 | 18.0000 | 964.0800 (32d) |
| Internal Ceiling 1 | 53.5600 | 9.0000  | 482.0400 (32e) |

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 19438.6400 (34)  
 Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K 181.4660 (35)

List of Thermal Bridges

| K1 Element                                       | Length  | Psi-value | Total  |
|--|---------|-----------|--------|
| E1 Steel lintel with perforated steel base plate | 13.7700 | 0.0500    | 0.6885 |
| E3 Sill  | 9.3500  | 0.0210    | 0.1963 |
| E4 Jamb  | 36.0000 | 0.0160    | 0.5760 |
| E5 Ground floor (normal)                         | 29.8500 | 0.1120    | 3.3432 |
| E6 Intermediate floor within a dwelling          | 29.8500 | 0.0020    | 0.0597 |
| E16 Corner (normal)                              | 17.2000 | 0.0510    | 0.8772 |
| R1 Head of roof window                           | 1.2700  | 0.2400    | 0.3048 |
| R2 Sill of roof window                           | 1.2700  | 0.2400    | 0.3048 |
| R3 Jamb of roof window                           | 2.2000  | 0.2400    | 0.5280 |
| E10 Eaves (insulation at ceiling level)          | 9.6500  | 0.0630    | 0.6079 |
| E11 Eaves (insulation at rafter level)           | 8.5100  | 0.0170    | 0.1447 |
| E12 Gable (insulation at ceiling level)          | 16.2900 | 0.0980    | 1.5964 |
| E13 Gable (insulation at rafter level)           | 4.8300  | 0.0510    | 0.2463 |
| R6 Flat ceiling                                  | 8.8300  | 0.0600    | 0.5298 |
| R7 Flat ceiling (inverted)                       | 18.6800 | 0.0600    | 1.1208 |
| R9 Roof to wall (flat ceiling)                   | 9.0300  | 0.1600    | 1.4448 |

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 12.5693 (36)  
 Point Thermal bridges (36a) = 0.0000  
 Total fabric heat loss (33) + (36) + (36a) = 64.8771 (37)

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

| (38)m                     | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
|---------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Heat transfer coeff       | 27.4770 | 27.0663 | 26.6557 | 24.6023 | 24.1916 | 22.1382 | 22.1382 | 21.7276 | 22.9596 | 24.1916 | 25.0130 | 25.8343 (38) |
| Average = Sum(39)m / 12 = | 92.3541 | 91.9435 | 91.5328 | 89.4794 | 89.0688 | 87.0154 | 87.0154 | 86.6047 | 87.8367 | 89.0688 | 89.8901 | 90.7114 (39) |
|                           |         |         |         |         |         |         |         |         |         |         |         | 89.3768      |
| HLP                       | 0.8622  | 0.8583  | 0.8545  | 0.8353  | 0.8315  | 0.8123  | 0.8123  | 0.8085  | 0.8200  | 0.8315  | 0.8392  | 0.8468 (40)  |
| HLP (average)             |         |         |         |         |         |         |         |         |         |         |         | 0.8344       |
| Days in mont              | 31      | 28      | 31      | 30      | 31      | 30      | 31      | 31      | 30      | 31      | 30      | 31           |

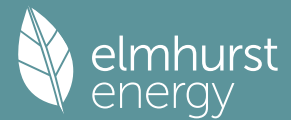
4. Water heating energy requirements (kWh/year)

| Assumed occupancy  | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec                          |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|------------------------------|
| Hot water usage for mixer showers  | 71.1060  | 70.0375  | 68.4803  | 65.5010  | 63.3024  | 60.8504  | 59.4568  | 61.0021  | 62.6961  | 65.3287  | 68.3720  | 70.8336 (42a)                |
| Hot water usage for baths  | 30.7011  | 30.2452  | 29.6031  | 28.4192  | 27.5328  | 26.5498  | 26.0188  | 26.6564  | 27.3507  | 28.4025  | 29.6107  | 30.5974 (42b)                |
| Hot water usage for other uses   | 43.2678  | 41.6944  | 40.1211  | 38.5477  | 36.9743  | 35.4009  | 35.4009  | 36.9743  | 38.5477  | 40.1211  | 41.6944  | 43.2678 (42c)                |
| Average daily hot water use (litres/day)                                       |          |          |          |          |          |          |          |          |          |          |          | 133.3566 (43)                |
| Daily hot water use  | 145.0750 | 141.9771 | 138.2045 | 132.4679 | 127.8094 | 122.8012 | 120.8766 | 124.6329 | 128.5945 | 133.8523 | 139.6772 | 144.6988 (44)                |
| Energy conte   | 229.7633 | 202.1735 | 212.4151 | 181.3420 | 172.0561 | 150.9984 | 146.1897 | 154.3215 | 158.5698 | 181.6362 | 198.9958 | 226.5633 (45)                |
| Energy content (annual)  |          |          |          |          |          |          |          |          |          |          |          | Total = Sum(45)m = 2215.0247 |
| Distribution loss (46)m = 0.15 x (45)m   | 34.4645  | 30.3260  | 31.8623  | 27.2013  | 25.8084  | 22.6498  | 21.9285  | 23.1482  | 23.7855  | 27.2454  | 29.8494  | 33.9845 (46)                 |
| Water storage loss:  |          |          |          |          |          |          |          |          |          |          |          | 250.0000 (47)                |
| Store volume   |          |          |          |          |          |          |          |          |          |          |          | 1.4000 (48)                  |
| a) If manufacturer declared loss factor is known (kWh/day):                    |          |          |          |          |          |          |          |          |          |          |          | 0.5400 (49)                  |
| Temperature factor from Table 2b   |          |          |          |          |          |          |          |          |          |          |          | 0.7560 (55)                  |
| Enter (49) or (54) in (55)   |          |          |          |          |          |          |          |          |          |          |          |                              |
| Total storage loss   | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (56)                 |
| If cylinder contains dedicated solar storage                                   | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (57)                 |
| Primary loss   | 23.2624  | 21.0112  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624 (59)                 |
| Combi loss   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (61)                  |
| Total heat required for water heating calculated for each month                | 276.4617 | 244.3527 | 259.1135 | 226.5340 | 218.7545 | 196.1904 | 192.8881 | 201.0199 | 203.7618 | 228.3346 | 244.1878 | 273.2617 (62)                |
| WWHRS  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63a)                 |
| PV diverter  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000 (63b)                |
| Solar input  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63c)                 |
| FGHRS  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63d)                 |
| Output from w/h  | 276.4617 | 244.3527 | 259.1135 | 226.5340 | 218.7545 | 196.1904 | 192.8881 | 201.0199 | 203.7618 | 228.3346 | 244.1878 | 273.2617 (64)                |
| Total per year (kWh/year)  |          |          |          |          |          |          |          |          |          |          |          | 2764.8607 (64)               |
| Electric shower(s)   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (64a)                 |
| Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (64a)                 |
| Heat gains from water heating, kWh/month                                       | 113.7550 | 100.9660 | 107.9868 | 96.4498  | 94.5674  | 86.3606  | 85.9668  | 88.6706  | 88.8781  | 97.7528  | 102.3197 | 112.6910 (65)                |

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

| Metabolic gains (Table 5), Watts  | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec            |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| (66)m   | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 141.6874  | 156.8682  | 141.6874  | 146.4103  | 141.6874  | 146.4103  | 141.6874  | 141.6874  | 146.4103  | 141.6874  | 146.4103  | 141.6874 (67)  |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 267.3514  | 270.1257  | 263.1346  | 248.2514  | 229.4641  | 211.8067  | 200.0104  | 197.2362  | 204.2272  | 219.1104  | 237.8977  | 255.5552 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819 (69)   |
| Pumps, fans   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 (71) |
| Water heating gains (Table 5)   | 152.8965  | 150.2471  | 145.1435  | 133.9581  | 127.1067  | 119.9452  | 115.5468  | 119.1810  | 123.4418  | 131.3881  | 142.1107  | 151.4664 (72)  |
| Total internal gains  | 626.8812  | 642.1868  | 614.9113  | 593.5657  | 563.2040  | 543.1081  | 522.1904  | 523.0503  | 539.0251  | 557.1318  | 591.3646  | 613.6548 (73)  |

# Full SAP Calculation Printout



## 6. Solar gains

| [Jan]       |          |          | Area<br>m <sup>2</sup> | Solar flux<br>Table 6a<br>W/m <sup>2</sup> | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W    |           |          |          |               |
|-------------|----------|----------|------------------------|--|-----------------------------------|------------------------------------|------------------------------|---------------|-----------|----------|----------|---------------|
| North       |          |          | 4.8500                 | 10.6334                                    | 0.5800                            | 0.0000                             | 0.7700                       | 23.0320 (74)  |           |          |          |               |
| East        |          |          | 0.7600                 | 19.6403                                    | 0.5800                            | 0.0000                             | 0.7700                       | 6.6662 (76)   |           |          |          |               |
| South       |          |          | 5.6100                 | 46.7521                                    | 0.5800                            | 0.0000                             | 0.7700                       | 117.1338 (78) |           |          |          |               |
| North       |          |          | 5.0400                 | 10.6334                                    | 0.6300                            | 0.7000                             | 0.7700                       | 16.3785 (74)  |           |          |          |               |
| South       |          |          | 1.4000                 | 47.0123                                    | 0.6300                            | 0.7000                             | 1.0000                       | 26.1229 (82)  |           |          |          |               |
| Solar gains | 189.3335 | 326.8103 | 462.0126               | 602.9460                                   | 707.2243                          | 717.2106                           | 685.1038                     | 604.2845      | 509.9668  | 364.8702 | 227.4790 | 161.6212 (83) |
| Total gains | 816.2146 | 968.9971 | 1076.9240              | 1196.5117                                  | 1270.4283                         | 1260.3187                          | 1207.2942                    | 1127.3348     | 1048.9919 | 922.0020 | 818.8435 | 775.2760 (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (C) 21.0000 (85)

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

|                        | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct                       | Nov     | Dec          |
|------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|--------------|
| tau                    | 58.4665 | 58.7276 | 58.9911 | 60.3448 | 60.6231 | 62.0537 | 62.0537 | 62.3479 | 61.4734 | 60.6231                   | 60.0692 | 59.5253      |
| alpha                  | 4.8978  | 4.9152  | 4.9327  | 5.0230  | 5.0415  | 5.1369  | 5.1369  | 5.1565  | 5.0982  | 5.0415                    | 5.0046  | 4.9684       |
| util living area       | 0.9786  | 0.9531  | 0.9053  | 0.7897  | 0.6236  | 0.4381  | 0.3165  | 0.3523  | 0.5623  | 0.8364                    | 0.9548  | 0.9826 (86)  |
| Living                 | 19.9819 | 20.2370 | 20.5168 | 20.8100 | 20.9502 | 20.9935 | 20.9990 | 20.9983 | 20.9776 | 20.7859                   | 20.3560 | 19.9524      |
| Non living             | 19.0168 | 19.3374 | 19.6815 | 20.0346 | 20.1838 | 20.2385 | 20.2422 | 20.2452 | 20.2202 | 20.0185                   | 19.5023 | 18.9895      |
| 24 / 16                | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0            |
| 24 / 9                 | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0            |
| 16 / 9                 | 28      | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 10           |
| MIT                    | 20.4792 | 20.2370 | 20.5168 | 20.8100 | 20.9502 | 20.9935 | 20.9990 | 20.9983 | 20.9776 | 20.7859                   | 20.3560 | 20.0989 (87) |
| Th 2                   | 20.1998 | 20.2031 | 20.2064 | 20.2228 | 20.2261 | 20.2427 | 20.2427 | 20.2460 | 20.2360 | 20.2261                   | 20.2195 | 20.2129 (88) |
| util rest of house     | 0.9742  | 0.9441  | 0.8881  | 0.7578  | 0.5790  | 0.3877  | 0.2623  | 0.2951  | 0.5053  | 0.8028                    | 0.9446  | 0.9789 (89)  |
| MIT 2                  | 19.7282 | 19.3374 | 19.6815 | 20.0346 | 20.1838 | 20.2385 | 20.2422 | 20.2452 | 20.2202 | 20.0185                   | 19.5023 | 19.2100 (90) |
| Living area fraction   |         |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         | 0.3780 (91)  |
| MIT                    | 20.0121 | 19.6774 | 19.9972 | 20.3277 | 20.4735 | 20.5238 | 20.5283 | 20.5299 | 20.5065 | 20.3086                   | 19.8250 | 19.5460 (92) |
| Temperature adjustment |         |         |         |         |         |         |         |         |         |                           |         | 0.0000       |
| adjusted MIT           | 20.0121 | 19.6774 | 19.9972 | 20.3277 | 20.4735 | 20.5238 | 20.5283 | 20.5299 | 20.5065 | 20.3086                   | 19.8250 | 19.5460 (93) |

## 8. Space heating requirement

|  | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct           | Nov       | Dec            |
|--|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|---------------|-----------|----------------|
| Utilisation  | 0.9730    | 0.9370    | 0.8830    | 0.7624    | 0.5935   | 0.4065   | 0.2828   | 0.3167   | 0.5258   | 0.8066        | 0.9384    | 0.9751 (94)    |
| Useful gains   | 794.1471  | 907.9621  | 950.9605  | 912.1728  | 754.0360 | 512.3674 | 341.4462 | 357.0103 | 551.5730 | 743.7034      | 768.3911  | 755.9396 (95)  |
| Ext temp.  | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000  | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000       | 7.1000    | 4.2000 (96)    |
| Heat loss rate W   | 1451.0735 | 1358.6901 | 1235.4359 | 1022.5456 | 781.4457 | 515.4650 | 341.8214 | 357.6668 | 562.7234 | 864.7338      | 1143.8520 | 1392.0586 (97) |
| Space heating kWh  | 488.7532  | 302.8892  | 211.6497  | 79.4684   | 20.3928  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 90.0467       | 270.3318  | 473.2726 (98a) |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |          |          |          |          |          |               |           | 1936.8045      |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000        | 0.0000    | 0.0000 (98b)   |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |          |          |          |          |          |               |           | 0.0000         |
| Space heating kWh  | 488.7532  | 302.8892  | 211.6497  | 79.4684   | 20.3928  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 90.0467       | 270.3318  | 473.2726 (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |          |          |          |          |          |               |           | 1936.8045      |
| Space heating per m <sup>2</sup>   |           |           |           |           |          |          |          |          |          | (98c) / (4) = |           | 18.0807 (99)   |

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

Fraction of space heat from secondary/supplementary system (Table 11) 0.0000 (201)

Fraction of space heat from main system(s) 1.0000 (202)

Efficiency of main space heating system 1 (in %) 273.8380 (206)

Efficiency of main space heating system 2 (in %) 0.0000 (207)

Efficiency of secondary/supplementary heating system, % 60.0000 (208)

|   | Jan      | Feb      | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct      | Nov      | Dec             |
|---|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|-----------------|
| Space heating requirement   | 488.7532 | 302.8892 | 211.6497  | 79.4684   | 20.3928   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 90.0467  | 270.3318 | 473.2726 (98)   |
| Space heating efficiency (main heating system 1)  | 273.8380 | 273.8380 | 273.8380  | 273.8380  | 273.8380  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 273.8380 | 273.8380 | 273.8380 (210)  |
| Space heating fuel (main heating system)  | 178.4826 | 110.6089 | 77.2901   | 29.0202   | 7.4470    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 32.8832  | 98.7196  | 172.8294 (211)  |
| Space heating efficiency (main heating system 2)  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (212)    |
| Space heating fuel (main heating system 2)  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (213)    |
| Space heating fuel (secondary)  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (215)    |
| Water heating   |          |          |           |           |           |           |           |           |           |          |          |                 |
| Water heating requirement   | 276.4617 | 244.3527 | 259.1135  | 226.5340  | 218.7545  | 196.1904  | 192.8881  | 201.0199  | 203.7618  | 228.3346 | 244.1878 | 273.2617 (64)   |
| Efficiency of water heater (217)m   | 284.3490 | 284.3490 | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490  | 284.3490 | 284.3490 | 284.3490 (216)  |
| Fuel for water heating, kWh/month   | 97.2262  | 85.9341  | 91.1252   | 79.6676   | 76.9317   | 68.9963   | 67.8350   | 70.6948   | 71.6591   | 80.3008  | 85.8761  | 96.1008 (219)   |
| Space cooling fuel requirement (221)m   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (221)    |
| Pumps and Fa  | 18.9800  | 17.1432  | 18.9800   | 18.3677   | 18.9800   | 18.3677   | 18.9800   | 18.9800   | 18.3677   | 18.9800  | 18.3677  | 18.9800 (231)   |
| Lighting  | 30.1218  | 24.1648  | 21.7578   | 15.9407   | 12.3130   | 10.0598   | 11.2324   | 14.6002   | 18.9643   | 24.8821  | 28.1043  | 30.9590 (232)   |
| Electricity generated by PVs (Appendix M) (negative quantity) (233a)m                       | -61.4812 | -84.8877 | -118.0843 | -126.8700 | -133.5249 | -123.3776 | -122.0874 | -116.2111 | -105.1403 | -92.7294 | -66.3282 | -53.2937 (233a) |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m             | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (234a)   |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000 (235a)   |

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|   |          |          |           |           |           |           |           |           |          |          |          |            |        |
|---|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|------------|--------|
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000     | (235c) |
| Electricity generated by PVs (Appendix M) (negative quantity) (233b)m   | -28.0603 | -59.4448 | -115.6626 | -171.2497 | -223.3645 | -221.7264 | -191.4592 | -146.4634 | -88.3603 | -38.8431 | -22.3565 |            | (233b) |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   |            | (234b) |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   |            | (235b) |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   |            | (235d) |
| Annual totals kWh/year  |          |          |           |           |           |           |           |           |          |          |          |            |        |
| Space heating fuel - main system 1  |          |          |           |           |           |           |           |           |          |          |          | 707.2810   | (211)  |
| Space heating fuel - main system 2  |          |          |           |           |           |           |           |           |          |          |          | 0.0000     | (213)  |
| Space heating fuel - secondary  |          |          |           |           |           |           |           |           |          |          |          | 0.0000     | (215)  |
| Efficiency of water heater  |          |          |           |           |           |           |           |           |          |          |          | 284.3490   |        |
| Water heating fuel used   |          |          |           |           |           |           |           |           |          |          |          | 972.3475   | (219)  |
| Space cooling fuel  |          |          |           |           |           |           |           |           |          |          |          | 0.0000     | (221)  |
| Electricity for pumps and fans:<br>(BalancedWithHeatRecovery, Database: in-use factor = 1.2500, SFP = 0.7125)<br>mechanical ventilation fans (SFP = 0.7125) |          |          |           |           |           |           |           |           |          |          |          | 223.4737   | (230a) |
| Total electricity for the above, kWh/year   |          |          |           |           |           |           |           |           |          |          |          | 223.4737   | (231)  |
| Electricity for lighting (calculated in Appendix L)   |          |          |           |           |           |           |           |           |          |          |          | 243.1003   | (232)  |
| Energy saving/generation technologies (Appendices M ,N and Q)   |          |          |           |           |           |           |           |           |          |          |          |            |        |
| PV generation   |          |          |           |           |           |           |           |           |          |          |          | -2734.2604 | (233)  |
| Wind generation   |          |          |           |           |           |           |           |           |          |          |          | 0.0000     | (234)  |
| Hydro-electric generation (Appendix N)  |          |          |           |           |           |           |           |           |          |          |          | 0.0000     | (235a) |
| Electricity generated - Micro CHP (Appendix N)  |          |          |           |           |           |           |           |           |          |          |          | 0.0000     | (235)  |
| Appendix Q - special features   |          |          |           |           |           |           |           |           |          |          |          |            |        |
| Energy saved or generated   |          |          |           |           |           |           |           |           |          |          |          | -0.0000    | (236)  |
| Energy used   |          |          |           |           |           |           |           |           |          |          |          | 0.0000     | (237)  |
| Total delivered energy for all uses   |          |          |           |           |           |           |           |           |          |          |          | -588.0579  | (238)  |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|   | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |       |
|---|-----------------|----------------------------|-----------------------|-------|
| Space heating - main system 1                   | 707.2810        | 0.1574                     | 111.2983              | (261) |
| Total CO2 associated with community systems     |                 |                            | 0.0000                | (373) |
| Water heating (other fuel)                      | 972.3475        | 0.1410                     | 137.1090              | (264) |
| Space and water heating                         |                 |                            | 248.4073              | (265) |
| Pumps, fans and electric keep-hot               | 223.4737        | 0.1387                     | 30.9986               | (267) |
| Energy for lighting                             | 243.1003        | 0.1443                     | 35.0869               | (268) |
| Energy saving/generation technologies           |                 |                            |                       |       |
| PV Unit electricity used in dwelling            | -1204.0159      | 0.1353                     | -162.9515             |       |
| PV Unit electricity exported                    | -1530.2445      | 0.1262                     | -193.1934             |       |
| Total   |                 |                            | -356.1448             | (269) |
| Total CO2, kg/year                              |                 |                            | -41.6520              | (272) |
| EPC Dwelling Carbon Dioxide Emission Rate (DER) |                 |                            | -0.3900               | (273) |

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

|   | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year |       |
|---|-----------------|----------------------------------|-------------------------|-------|
| Space heating - main system 1               | 707.2810        | 1.5825                           | 1119.2745               | (275) |
| Total CO2 associated with community systems |                 |                                  | 0.0000                  | (473) |
| Water heating (other fuel)                  | 972.3475        | 1.5214                           | 1479.3321               | (278) |
| Space and water heating                     |                 |                                  | 2598.6066               | (279) |
| Pumps, fans and electric keep-hot           | 223.4737        | 1.5128                           | 338.0711                | (281) |
| Energy for lighting                         | 243.1003        | 1.5338                           | 372.8753                | (282) |
| Energy saving/generation technologies       |                 |                                  |                         |       |
| PV Unit electricity used in dwelling        | -1204.0159      | 1.5002                           | -1806.3103              |       |
| PV Unit electricity exported                | -1530.2445      | 0.4635                           | -709.2088               |       |
| Total                                       |                 |                                  | -2515.5191              | (283) |
| Total Primary energy kWh/year               |                 |                                  | 794.0339                | (286) |
| Dwelling Primary energy Rate (DPER)         |                 |                                  | 7.4100                  | (287) |

## SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022) CALCULATION OF TARGET EMISSIONS

### 1. Overall dwelling characteristics

|  | Area (m <sup>2</sup> ) | Storey height (m)               | Volume (m <sup>3</sup> ) |  |
|--|------------------------|---------------------------------|--------------------------|--|
| Ground floor   | 53.5600 (1b)           | x 2.5000 (2b)                   | = 133.9000 (1b) - (3b)   |  |
| First floor  | 53.5600 (1c)           | x 2.3000 (2c)                   | = 123.1880 (1c) - (3c)   |  |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 107.1200               |                                 | (4)                      |  |
| Dwelling volume  |                        | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 257.0880 (5)           |  |

### 2. Ventilation rate

|  | m <sup>3</sup> per hour |             |
|--|-------------------------|-------------|
| Number of open chimneys                            | 0 * 80 =                | 0.0000 (6a) |
| Number of open flues                               | 0 * 20 =                | 0.0000 (6b) |
| Number of chimneys / flues attached to closed fire | 0 * 10 =                | 0.0000 (6c) |
| Number of flues attached to solid fuel boiler      | 0 * 20 =                | 0.0000 (6d) |

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Number of flues attached to other heater 0 \* 35 = 0.0000 (6e)  
 Number of blocked chimneys 0 \* 20 = 0.0000 (6f)  
 Number of intermittent extract fans 4 \* 10 = 40.0000 (7a)  
 Number of passive vents 0 \* 10 = 0.0000 (7b)  
 Number of flueless gas fires 0 \* 40 = 0.0000 (7c)

Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = 40.0000 / (5) = 0.1556 (8)  
 Pressure test Yes  
 Pressure Test Method Blower Door  
 Measured/design AP50 5.0000 (17)  
 Infiltration rate 0.4056 (18)  
 Number of sides sheltered 2 (19)  
 Shelter factor (20) = 1 - [0.075 x (19)] = 0.8500 (20)  
 Infiltration rate adjusted to include shelter factor (21) = (18) x (20) = 0.3448 (21)

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)  |
| Wind factor     | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac    | 0.4396 | 0.4309 | 0.4223 | 0.3792 | 0.3706 | 0.3275 | 0.3275 | 0.3189 | 0.3448 | 0.3706 | 0.3878 | 0.4051 (22b) |
|                 | 0.5966 | 0.5929 | 0.5892 | 0.5719 | 0.5687 | 0.5536 | 0.5536 | 0.5508 | 0.5594 | 0.5687 | 0.5752 | 0.5820 (25)  |

### 3. Heat losses and heat loss parameter

| Element  | Gross m2 | Openings m2 | NetArea m2 | U-value W/m2K | A x U W/K            | K-value kJ/m2K | A x K kJ/K |
|--|----------|-------------|------------|---------------|----------------------|----------------|------------|
| TER Opaque door                                |          |             | 2.1200     | 1.0000        | 2.1200               |                | (26)       |
| TER Semi-glazed door                           |          |             | 2.1200     | 1.0000        | 2.1200               |                | (26a)      |
| TER Opening Type (Uw = 1.20)                   |          |             | 16.2600    | 1.1450        | 18.6183              |                | (27)       |
| Front  |          |             | 1.4000     | 1.4151        | 1.9811               |                | (27a)      |
| Ground Floor                                   |          |             | 53.5600    | 0.1300        | 6.9628               |                | (28a)      |
| External Wall 1                                | 128.6600 | 20.5000     | 108.1600   | 0.1800        | 19.4688              |                | (29a)      |
| Dormer Cheek                                   | 14.6200  |             | 14.6200    | 0.1800        | 2.6316               |                | (29a)      |
| Cold Roof                                      | 32.1100  |             | 32.1100    | 0.1100        | 3.5321               |                | (30)       |
| Sloping Roof                                   | 15.7200  | 1.4000      | 14.3200    | 0.1100        | 1.5752               |                | (30)       |
| Dormer Roof                                    | 10.9200  |             | 10.9200    | 0.1100        | 1.2012               |                | (30)       |
| Total net area of external elements Aum(A, m2) |          |             | 255.5900   |               |                      |                | (31)       |
| Fabric heat loss, W/K = Sum (A x U)            |          |             |            |               | 60.2112              |                | (33)       |
|  |          |             |            |               | (26)...(30) + (32) = |                |            |

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 181.4660 (35)

#### List of Thermal Bridges

| K1 Element                                       | Length  | Psi-value | Total  |
|--|---------|-----------|--------|
| E1 Steel lintel with perforated steel base plate | 13.7700 | 0.0500    | 0.6885 |
| E3 Sill  | 9.3500  | 0.0500    | 0.4675 |
| E4 Jamb  | 36.0000 | 0.0500    | 1.8000 |
| E5 Ground floor (normal)                         | 29.8500 | 0.1600    | 4.7760 |
| E6 Intermediate floor within a dwelling          | 29.8500 | 0.0000    | 0.0000 |
| E16 Corner (normal)                              | 17.2000 | 0.0900    | 1.5480 |
| R1 Head of roof window                           | 1.2700  | 0.0800    | 0.1016 |
| R2 Sill of roof window                           | 1.2700  | 0.0600    | 0.0762 |
| R3 Jamb of roof window                           | 2.2000  | 0.0800    | 0.1760 |
| E10 Eaves (insulation at ceiling level)          | 9.6500  | 0.0600    | 0.5790 |
| E11 Eaves (insulation at rafter level)           | 8.5100  | 0.0400    | 0.3404 |
| E12 Gable (insulation at ceiling level)          | 16.2900 | 0.0600    | 0.9774 |
| E13 Gable (insulation at rafter level)           | 4.8300  | 0.0800    | 0.3864 |
| R6 Flat ceiling                                  | 8.8300  | 0.0600    | 0.5298 |
| R7 Flat ceiling (inverted)                       | 18.6800 | 0.0400    | 0.7472 |
| R9 Roof to wall (flat ceiling)                   | 9.0300  | 0.0400    | 0.3612 |

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 13.5552 (36)  
 Point Thermal bridges (36a) = 0.0000  
 Total fabric heat loss (33) + (36) + (36a) = 73.7664 (37)

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

| (38)m                     | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|---------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Heat transfer coeff       | 50.6154  | 50.2971  | 49.9852  | 48.5200  | 48.2458  | 46.9696  | 46.9696  | 46.7333  | 47.4612  | 48.2458  | 48.8004  | 49.3802 (38)  |
| Average = Sum(39)m / 12 = | 124.3818 | 124.0635 | 123.7515 | 122.2863 | 122.0122 | 120.7360 | 120.7360 | 120.4997 | 121.2276 | 122.0122 | 122.5668 | 123.1465 (39) |

| HLP           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec         |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| HLP (average) | 1.1611 | 1.1582 | 1.1553 | 1.1416 | 1.1390 | 1.1271 | 1.1271 | 1.1249 | 1.1317 | 1.1390 | 1.1442 | 1.1496 (40) |
| Days in mont  | 31     | 28     | 31     | 30     | 31     | 30     | 31     | 31     | 30     | 31     | 30     | 31          |

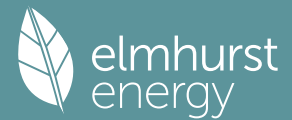
### 4. Water heating energy requirements (kWh/year)

| Assumed occupancy                        | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec           |
|--|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------------|
| Hot water usage for mixer showers        | 71.1060 | 70.0375 | 68.4803 | 65.5010 | 63.3024 | 60.8504 | 59.4568 | 61.0021 | 62.6961 | 65.3287 | 68.3720 | 70.8336 (42a) |
| Hot water usage for baths                | 30.7011 | 30.2452 | 29.6031 | 28.4192 | 27.5328 | 26.5498 | 26.0188 | 26.6564 | 27.3507 | 28.4025 | 29.6107 | 30.5974 (42b) |
| Hot water usage for other uses           | 43.2678 | 41.6944 | 40.1211 | 38.5477 | 36.9743 | 35.4009 | 35.4009 | 36.9743 | 38.5477 | 40.1211 | 41.6944 | 43.2678 (42c) |
| Average daily hot water use (litres/day) | 34.4645 | 30.3260 | 31.8623 | 27.2013 | 25.8084 | 22.6498 | 21.9285 | 23.1482 | 23.7855 | 27.2454 | 29.8494 | 33.9845 (43)  |

| Daily hot water use                    | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Energy conte                           | 145.0750 | 141.9771 | 138.2045 | 132.4679 | 127.8094 | 122.8012 | 120.8766 | 124.6329 | 128.5945 | 133.8523 | 139.6772 | 144.6988 (44) |
| Energy content (annual)                | 229.7633 | 202.1735 | 212.4151 | 181.3420 | 172.0561 | 150.9984 | 146.1897 | 154.3215 | 158.5698 | 181.6362 | 198.9958 | 226.5633 (45) |
| Distribution loss (46)m = 0.15 x (45)m | 34.4645  | 30.3260  | 31.8623  | 27.2013  | 25.8084  | 22.6498  | 21.9285  | 23.1482  | 23.7855  | 27.2454  | 29.8494  | 33.9845 (46)  |

Water storage loss:  
 Store volume 250.0000 (47)  
 a) If manufacturer declared loss factor is known (kWh/day):  
 Temperature factor from Table 2b 1.8903 (48)  
 Enter (49) or (54) in (55) 0.5400 (49)  
 Total storage loss 1.0208 (55)  
 31.6444 28.5820 31.6444 30.6236 31.6444 30.6236 31.6444 31.6444 30.6236 31.6444 30.6236 31.6444 30.6236 (56)  
 If cylinder contains dedicated solar storage 31.6444 28.5820 31.6444 30.6236 31.6444 30.6236 31.6444 31.6444 30.6236 31.6444 30.6236 31.6444 30.6236 (57)

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|   |          |          |          |          |          |          |          |          |          |          |  |                |                |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|--|----------------|----------------|
| Primary loss  | 23.2624  | 21.0112  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624 (59)   |                |
| Combi loss  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (61)    |                |
| Total heat required for water heating calculated for each month |          |          |          |          |          |          |          |          |          |          |  |                |                |
|   | 284.6701 | 251.7667 | 267.3219 | 234.4776 | 226.9628 | 204.1340 | 201.0965 | 209.2283 | 211.7054 | 236.5430 | 252.1314   | 281.4701 (62)  |                |
| WWHRS   | -32.5067 | -28.7492 | -30.1045 | -24.9277 | -23.2317 | -19.8796 | -18.6339 | -19.8153 | -20.5682 | -24.2476 | -27.4696   | -31.9047 (63a) |                |
| PV diverter   | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000 (63b)  |                |
| Solar input   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63c)   |                |
| FGHRS   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63d)   |                |
| Output from w/h   |          |          |          |          |          |          |          |          |          |          |  |                |                |
|   | 252.1634 | 223.0175 | 237.2174 | 209.5499 | 203.7311 | 184.2544 | 182.4626 | 189.4130 | 191.1373 | 212.2954 | 224.6618   | 249.5654 (64)  |                |
|   |          |          |          |          |          |          |          |          |          |          | Total per year (kWh/year) = Sum(64)m =   |                | 2559.4691 (64) |
|   |          |          |          |          |          |          |          |          |          |          |  |                | 2559 (64)      |
| 12Total per year (kWh/year)                                     |          |          |          |          |          |          |          |          |          |          |  |                |                |
| Electric shower(s)  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (64a)   |                |
|   |          |          |          |          |          |          |          |          |          |          | Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = |                | 0.0000 (64a)   |
| Heat gains from water heating, kWh/month                        |          |          |          |          |          |          |          |          |          |          |  |                |                |
|   | 120.3217 | 106.8973 | 114.5535 | 102.8047 | 101.1341 | 92.7154  | 92.5335  | 95.2373  | 95.2330  | 104.3195 | 108.6746   | 119.2577 (65)  |                |

## 5. Internal gains (see Table 5 and 5a)

|   |           |           |           |           |           |           |           |           |           |           |           |                |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| Metabolic gains (Table 5), Watts  |           |           |           |           |           |           |           |           |           |           |           |                |
| (66)m   | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194  | 139.8194 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 139.4494  | 154.3904  | 139.4494  | 144.0977  | 139.4494  | 144.0977  | 139.4494  | 139.4494  | 144.0977  | 139.4494  | 144.0977  | 139.4494 (67)  |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 267.3514  | 270.1257  | 263.1346  | 248.2514  | 229.4641  | 211.8067  | 200.0104  | 197.2362  | 204.2272  | 219.1104  | 237.8977  | 255.5552 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819   | 36.9819 (69)   |
| Pumps, fans   |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 3.0000    | 3.0000    | 3.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 |           |           |           |           |           |           |           |           |           |           |           |                |
|   | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 | -111.8555 (71) |
| Water heating gains (Table 5)   |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 161.7228  | 159.0733  | 153.9697  | 142.7843  | 135.9329  | 128.7714  | 124.3730  | 128.0072  | 132.2680  | 140.2144  | 150.9369  | 160.2926 (72)  |
| Total internal gains  |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 636.4694  | 651.5352  | 624.4995  | 603.0793  | 572.7922  | 549.6217  | 528.7786  | 529.6385  | 545.5387  | 566.7200  | 600.8782  | 623.2430 (73)  |

## 6. Solar gains

|             |          |            |                                |                                   |                                    |                              |              |           |          |          |          |               |
|-------------|----------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|--------------|-----------|----------|----------|----------|---------------|
| [Jan]       |          | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W   |           |          |          |          |               |
| North       |          | 9.8900     | 10.6334                        | 0.6300                            | 0.7000                             | 0.7700                       | 32.1396 (74) |           |          |          |          |               |
| East        |          | 0.7600     | 19.6403                        | 0.6300                            | 0.7000                             | 0.7700                       | 4.5618 (76)  |           |          |          |          |               |
| South       |          | 5.6100     | 46.7521                        | 0.6300                            | 0.7000                             | 0.7700                       | 80.1559 (78) |           |          |          |          |               |
| South       |          | 1.4000     | 47.0123                        | 0.6300                            | 0.7000                             | 1.0000                       | 26.1229 (82) |           |          |          |          |               |
| -----       |          |            |                                |                                   |                                    |                              |              |           |          |          |          |               |
| Solar gains | 142.9801 | 248.2380   | 354.4784                       | 467.9438                          | 553.1610                           | 562.6765                     | 536.8004     | 470.6631  | 393.1081 | 278.1249 | 172.0538 | 121.8768 (83) |
| Total gains | 779.4495 | 899.7732   | 978.9780                       | 1071.0231                         | 1125.9532                          | 1112.2981                    | 1065.5790    | 1000.3016 | 938.6468 | 844.8449 | 772.9320 | 745.1198 (84) |

## 7. Mean internal temperature (heating season)

|   |         |         |         |         |         |         |         |         |         |         |         |              |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         |              |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |         |         | 21.0000 (85) |
|   | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
| tau   | 43.4117 | 43.5231 | 43.6328 | 44.1556 | 44.2548 | 44.7226 | 44.7226 | 44.8103 | 44.5412 | 44.2548 | 44.0545 | 43.8471      |
| alpha   | 3.8941  | 3.9015  | 3.9089  | 3.9437  | 3.9503  | 3.9815  | 3.9815  | 3.9874  | 3.9694  | 3.9503  | 3.9370  | 3.9231       |
| util living area  |         |         |         |         |         |         |         |         |         |         |         |              |
|   | 0.9861  | 0.9750  | 0.9552  | 0.9032  | 0.8011  | 0.6353  | 0.4824  | 0.5294  | 0.7503  | 0.9227  | 0.9752  | 0.9883 (86)  |
| MIT   |         |         |         |         |         |         |         |         |         |         |         |              |
|   | 19.3326 | 19.5717 | 19.9035 | 20.3442 | 20.7019 | 20.9151 | 20.9779 | 20.9682 | 20.8304 | 20.3731 | 19.7847 | 19.2975 (87) |
| Th 2  | 19.9512 | 19.9536 | 19.9560 | 19.9670 | 19.9691 | 19.9788 | 19.9788 | 19.9805 | 19.9750 | 19.9691 | 19.9649 | 19.9605 (88) |
| util rest of house  |         |         |         |         |         |         |         |         |         |         |         |              |
|   | 0.9828  | 0.9691  | 0.9442  | 0.8790  | 0.7520  | 0.5532  | 0.3776  | 0.4226  | 0.6768  | 0.8982  | 0.9683  | 0.9855 (89)  |
| MIT 2   | 18.0207 | 18.3245 | 18.7429 | 19.2905 | 19.7025 | 19.9226 | 19.9696 | 19.9662 | 19.8483 | 19.3374 | 18.6050 | 17.9823 (90) |
| Living area fraction  |         |         |         |         |         |         |         |         |         |         |         |              |
|   | 18.5165 | 18.7959 | 19.1816 | 19.6888 | 20.0803 | 20.2978 | 20.3507 | 20.3449 | 20.2196 | 19.7289 | 19.0509 | 18.4794 (92) |
| Temperature adjustment  |         |         |         |         |         |         |         |         |         |         |         |              |
| adjusted MIT  | 18.5165 | 18.7959 | 19.1816 | 19.6888 | 20.0803 | 20.2978 | 20.3507 | 20.3449 | 20.2196 | 19.7289 | 19.0509 | 18.4794 (93) |

## 8. Space heating requirement

|  |           |           |           |           |           |          |          |          |          |           |               |                |              |
|--|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|---------------|----------------|--------------|
|  | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct       | Nov           | Dec            |              |
| Utilisation  | 0.9765    | 0.9606    | 0.9340    | 0.8714    | 0.7578    | 0.5801   | 0.4168   | 0.4621   | 0.6959   | 0.8913    | 0.9602        | 0.9799 (94)    |              |
| Useful gains   | 761.1713  | 864.2788  | 914.3906  | 933.3274  | 853.2936  | 645.2901 | 444.0952 | 462.1957 | 653.1929 | 753.0012  | 742.1531      | 730.1138 (95)  |              |
| Ext temp.  | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000   | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000   | 7.1000        | 4.2000 (96)    |              |
| Heat loss rate W   |           |           |           |           |           |          |          |          |          |           |               |                |              |
|  | 1768.2775 | 1723.9772 | 1569.3687 | 1319.3194 | 1022.4965 | 687.9276 | 452.8478 | 475.3605 | 741.8587 | 1113.8381 | 1464.7854     | 1758.4626 (97) |              |
| Space heating kWh  |           |           |           |           |           |          |          |          |          |           |               |                |              |
|  | 749.2870  | 577.7174  | 487.3037  | 277.9142  | 125.8870  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 268.4627  | 520.2953      | 765.0915 (98a) |              |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |           |          |          |          |          |           |               |                |              |
|  |           |           |           |           |           |          |          |          |          |           |               | 3771.9588      |              |
| Solar heating kWh  |           |           |           |           |           |          |          |          |          |           |               |                |              |
|  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000        | 0.0000 (98b)   |              |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |           |          |          |          |          |           |               |                |              |
|  | 749.2870  | 577.7174  | 487.3037  | 277.9142  | 125.8870  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 268.4627  | 520.2953      | 765.0915 (98c) |              |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |           |          |          |          |          |           |               |                |              |
|  |           |           |           |           |           |          |          |          |          |           |               | 3771.9588      |              |
|  |           |           |           |           |           |          |          |          |          |           | (98c) / (4) = |                | 35.2125 (99) |

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

|   |  |  |  |  |  |  |  |  |  |  |  |              |
|---|--|--|--|--|--|--|--|--|--|--|--|--------------|
| Fraction of space heat from secondary/supplementary system (Table 11) |  |  |  |  |  |  |  |  |  |  |  | 0.0000 (201) |
| Fraction of space heat from main system(s)                            |  |  |  |  |  |  |  |  |  |  |  | 1.0000 (202) |



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|  | Jan      | Feb      | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct      | Nov      | Dec      |                  |
|--|----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|------------------|
| Efficiency of main space heating system 1 (in %)   |          |          |           |           |           |           |           |           |           |          |          |          | 92.3000 (206)    |
| Efficiency of main space heating system 2 (in %)   |          |          |           |           |           |           |           |           |           |          |          |          | 0.0000 (207)     |
| Efficiency of secondary/supplementary heating system, %  |          |          |           |           |           |           |           |           |           |          |          |          | 0.0000 (208)     |
| Space heating requirement  | 749.2870 | 577.7174 | 487.3037  | 277.9142  | 125.8870  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 268.4627 | 520.2953 | 765.0915 | (98)             |
| Space heating efficiency (main heating system 1)   | 92.3000  | 92.3000  | 92.3000   | 92.3000   | 92.3000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 92.3000  | 92.3000  | 92.3000  | (210)            |
| Space heating fuel (main heating system)   | 811.7953 | 625.9126 | 527.9564  | 301.0988  | 136.3889  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 290.8588 | 563.7002 | 828.9182 | (211)            |
| Space heating efficiency (main heating system 2)   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (212)            |
| Space heating fuel (main heating system 2)   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (213)            |
| Space heating fuel (secondary)   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (215)            |
| Water heating requirement  | 252.1634 | 223.0175 | 237.2174  | 209.5499  | 203.7311  | 184.2544  | 182.4626  | 189.4130  | 191.1373  | 212.2954 | 224.6618 | 249.5654 | (64)             |
| Efficiency of water heater (217)m  | 86.3479  | 86.0956  | 85.6377   | 84.6938   | 83.0133   | 79.8000   | 79.8000   | 79.8000   | 79.8000   | 84.5873  | 85.8790  | 79.8000  | (216)            |
| Fuel for water heating, kWh/month  | 292.0320 | 259.0347 | 277.0011  | 247.4204  | 245.4199  | 230.8952  | 228.6499  | 237.3597  | 239.5204  | 250.9779 | 261.6026 | 288.8381 | (219)            |
| Space cooling fuel requirement (221)m  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (221)            |
| Pumps and Fa   | 7.3041   | 6.5973   | 7.3041    | 7.0685    | 7.3041    | 7.0685    | 7.3041    | 7.3041    | 7.0685    | 7.3041   | 7.0685   | 7.3041   | (231)            |
| Lighting   | 28.9748  | 23.2447  | 20.9293   | 15.3337   | 11.8442   | 9.6768    | 10.8046   | 14.0443   | 18.2421   | 23.9347  | 27.0342  | 29.7801  | (232)            |
| Electricity generated by PVs (Appendix M) (negative quantity) (233a)m  | -48.6614 | -67.8706 | -96.5113  | -107.2837 | -114.6173 | -106.5475 | -105.1687 | -99.7679  | -90.1318  | -76.9697 | -53.2122 | -42.1520 | (233a)           |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234a)m                              | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (234a)           |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235a)m                  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (235a)           |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235c)m | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (235c)           |
| Electricity generated by PVs (Appendix M) (negative quantity) (233b)m  | -29.7610 | -62.3362 | -123.4270 | -184.7270 | -243.6640 | -244.6632 | -241.8405 | -205.0839 | -150.7053 | -88.9954 | -39.6800 | -23.5597 | (233b)           |
| Electricity generated by wind turbines (Appendix M) (negative quantity) (234b)m                              | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (234b)           |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity) (235b)m                  | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (235b)           |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) (235d)m | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | (235d)           |
| Annual totals kWh/year   |          |          |           |           |           |           |           |           |           |          |          |          |                  |
| Space heating fuel - main system 1   |          |          |           |           |           |           |           |           |           |          |          |          | 4086.6292 (211)  |
| Space heating fuel - main system 2   |          |          |           |           |           |           |           |           |           |          |          |          | 0.0000 (213)     |
| Space heating fuel - secondary   |          |          |           |           |           |           |           |           |           |          |          |          | 0.0000 (215)     |
| Efficiency of water heater   |          |          |           |           |           |           |           |           |           |          |          |          | 79.8000          |
| Water heating fuel used  |          |          |           |           |           |           |           |           |           |          |          |          | 3058.7519 (219)  |
| Space cooling fuel   |          |          |           |           |           |           |           |           |           |          |          |          | 0.0000 (221)     |
| Electricity for pumps and fans:  |          |          |           |           |           |           |           |           |           |          |          |          |                  |
| Total electricity for the above, kWh/year  |          |          |           |           |           |           |           |           |           |          |          |          | 86.0000 (231)    |
| Electricity for lighting (calculated in Appendix L)  |          |          |           |           |           |           |           |           |           |          |          |          | 233.8435 (232)   |
| Energy saving/generation technologies (Appendices M ,N and Q)  |          |          |           |           |           |           |           |           |           |          |          |          |                  |
| PV generation  |          |          |           |           |           |           |           |           |           |          |          |          | -2647.3372 (233) |
| Wind generation  |          |          |           |           |           |           |           |           |           |          |          |          | 0.0000 (234)     |
| Hydro-electric generation (Appendix N)   |          |          |           |           |           |           |           |           |           |          |          |          | 0.0000 (235a)    |
| Electricity generated - Micro CHP (Appendix N)   |          |          |           |           |           |           |           |           |           |          |          |          | 0.0000 (235)     |
| Appendix Q - special features  |          |          |           |           |           |           |           |           |           |          |          |          |                  |
| Energy saved or generated  |          |          |           |           |           |           |           |           |           |          |          |          | -0.0000 (236)    |
| Energy used  |          |          |           |           |           |           |           |           |           |          |          |          | 0.0000 (237)     |
| Total delivered energy for all uses  |          |          |           |           |           |           |           |           |           |          |          |          | 4817.8874 (238)  |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|   | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |
|---|-----------------|----------------------------|-----------------------|
| Space heating - main system 1                 | 4086.6292       | 0.2100                     | 858.1921 (261)        |
| Total CO2 associated with community systems   |                 |                            | 0.0000 (373)          |
| Water heating (other fuel)                    | 3058.7519       | 0.2100                     | 642.3379 (264)        |
| Space and water heating                       |                 |                            | 1500.5300 (265)       |
| Pumps, fans and electric keep-hot             | 86.0000         | 0.1387                     | 11.9293 (267)         |
| Energy for lighting                           | 233.8435        | 0.1443                     | 33.7508 (268)         |
| Energy saving/generation technologies         |                 |                            |                       |
| PV Unit electricity used in dwelling          | -1008.8941      | 0.1348                     | -136.0316             |
| PV Unit electricity exported                  | -1638.4431      | 0.1260                     | -206.4352             |
| Total   |                 |                            | -342.4668 (269)       |
| Total CO2, kg/year                            |                 |                            | 1203.7434 (272)       |
| EPC Target Carbon Dioxide Emission Rate (TER) |                 |                            | 11.2400 (273)         |

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

|   | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year |
|---|-----------------|----------------------------------|-------------------------|
| Space heating - main system 1               | 4086.6292       | 1.1300                           | 4617.8910 (275)         |
| Total CO2 associated with community systems |                 |                                  | 0.0000 (473)            |
| Water heating (other fuel)                  | 3058.7519       | 1.1300                           | 3456.3896 (278)         |
| Space and water heating                     |                 |                                  | 8074.2807 (279)         |
| Pumps, fans and electric keep-hot           | 86.0000         | 1.5128                           | 130.1008 (281)          |
| Energy for lighting                         | 233.8435        | 1.5338                           | 358.6769 (282)          |
| Energy saving/generation technologies       |                 |                                  |                         |
| PV Unit electricity used in dwelling        | -1008.8941      | 1.4983                           | -1511.6578              |
| PV Unit electricity exported                | -1638.4431      | 0.4625                           | -757.7657               |
| Total                                       |                 |                                  | -2269.4235 (283)        |
| Total Primary energy kWh/year               |                 |                                  | 6293.6349 (286)         |
| Target Primary Energy Rate (TPER)           |                 |                                  | 58.7500 (287)           |



# Full SAP Calculation Printout



|                                    |   |               |                |             |           |
|------------------------------------|---|---------------|----------------|-------------|-----------|
| Property Reference                 | Plot 2  |               | Issued on Date | 21/12/2023  |           |
| Assessment Reference               | 00001   | Prop Type Ref | Plot 2         |             |           |
| Property                           | Plot 2, Ryeland, Trevanna Cross, St Mawgan, Cornwall, TR8 4HB |               |                |             |           |
| SAP Rating                         | 98 A  | DER           | -0.36          | TER         | 10.47     |
| Environmental                      | 100 A   | % DER < TER   |                | 103.44      |           |
| CO <sub>2</sub> Emissions (t/year) | -0.17   | DFEE          | 37.83          | TFEE        | 44.67     |
| Compliance Check                   | See BREL  | % DFEE < TFEE |                | 15.32       |           |
| % DPER < TPER                      | 86.45   | DPER          | 7.44           | TPER        | 54.91     |
| Assessor Details                   | Mr. Matthew Fitzpatrick                                       |               |                | Assessor ID | 7601-0001 |
| Client                             |   |               |                |             |           |

SAP 10 WORKSHEET FOR New Build (As Designed) (Version 10.2, February 2022)  
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE

## 1. Overall dwelling characteristics

|  | Area (m <sup>2</sup> ) | Storey height (m)               | Volume (m <sup>3</sup> ) |
|--|------------------------|---------------------------------|--------------------------|
| Ground floor   | 74.7200 (1b)           | x 2.5000 (2b)                   | = 186.8000 (1b) - (3b)   |
| First floor  | 65.1500 (1c)           | x 2.3000 (2c)                   | = 149.8450 (1c) - (3c)   |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 139.8700               |                                 | (4)                      |
| Dwelling volume  |                        | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 336.6450 (5)           |

## 2. Ventilation rate

|   | m3 per hour                 |        |        |        |        |        |        |        |        |        |        |               |
|---|-----------------------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|---------------|
| Number of open chimneys   | 0 * 80 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6a)   |
| Number of open flues  | 1 * 20 =                    |        |        |        |        |        |        |        |        |        |        | 20.0000 (6b)  |
| Number of chimneys / flues attached to closed fire  | 0 * 10 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6c)   |
| Number of flues attached to solid fuel boiler   | 0 * 20 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6d)   |
| Number of flues attached to other heater  | 0 * 35 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6e)   |
| Number of blocked chimneys  | 0 * 20 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (6f)   |
| Number of intermittent extract fans   | 0 * 10 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (7a)   |
| Number of passive vents   | 0 * 10 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (7b)   |
| Number of flueless gas fires  | 0 * 40 =                    |        |        |        |        |        |        |        |        |        |        | 0.0000 (7c)   |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) =      | 20.0000 / (5) =             |        |        |        |        |        |        |        |        |        |        | 0.0594 (8)    |
| Pressure test   |                             |        |        |        |        |        |        |        |        |        |        | Yes           |
| Pressure Test Method  |                             |        |        |        |        |        |        |        |        |        |        | Blower Door   |
| Measured/design AP50  |                             |        |        |        |        |        |        |        |        |        |        | 2.0000 (17)   |
| Infiltration rate   |                             |        |        |        |        |        |        |        |        |        |        | 0.1594 (18)   |
| Number of sides sheltered   |                             |        |        |        |        |        |        |        |        |        |        | 2 (19)        |
| Shelter factor  | (20) = 1 - [0.075 x (19)] = |        |        |        |        |        |        |        |        |        |        | 0.8500 (20)   |
| Infiltration rate adjusted to include shelter factor  | (21) = (18) x (20) =        |        |        |        |        |        |        |        |        |        |        | 0.1355 (21)   |
| Wind speed  | Jan                         | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec           |
| Wind factor   | 5.1000                      | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)   |
| Adj infilt rate   | 1.2750                      | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a)  |
| Balanced mechanical ventilation with heat recovery  | 0.1728                      | 0.1694 | 0.1660 | 0.1490 | 0.1457 | 0.1287 | 0.1287 | 0.1253 | 0.1355 | 0.1457 | 0.1524 | 0.1592 (22b)  |
| If mechanical ventilation   |                             |        |        |        |        |        |        |        |        |        |        | 0.5000 (23a)  |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |                             |        |        |        |        |        |        |        |        |        |        | 0.5000 (23b)  |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) =            |                             |        |        |        |        |        |        |        |        |        |        | 84.6000 (23c) |
| Effective ac  | 0.2498                      | 0.2464 | 0.2430 | 0.2260 | 0.2227 | 0.2057 | 0.2057 | 0.2023 | 0.2125 | 0.2227 | 0.2294 | 0.2362 (25)   |

## 3. Heat losses and heat loss parameter

| Element   | Gross m <sup>2</sup> | Openings m <sup>2</sup> | NetArea m <sup>2</sup> | U-value W/m <sup>2</sup> K | A x U W/K | K-value kJ/m <sup>2</sup> K | A x K kJ/K       |
|---|----------------------|-------------------------|------------------------|----------------------------|-----------|-----------------------------|------------------|
| Front door  |                      |                         | 3.1500                 | 1.2000                     | 3.7800    |                             | (26)             |
| Utility Door  |                      |                         | 2.1200                 | 1.2000                     | 2.5440    |                             | (26a)            |
| Window (Uw = 0.80)  |                      |                         | 15.8000                | 0.7752                     | 12.2481   |                             | (27)             |
| Patio Door (Uw = 1.00)                                      |                      |                         | 12.6000                | 0.9615                     | 12.1154   |                             | (27)             |
| Front   |                      |                         | 1.4000                 | 1.0536                     | 1.4751    |                             | (27a)            |
| Side  |                      |                         | 0.7400                 | 1.0536                     | 0.7797    |                             | (27a)            |
| Rear  |                      |                         | 2.2100                 | 1.0536                     | 2.3285    |                             | (27a)            |
| Ground Floor  |                      |                         | 74.7200                | 0.1200                     | 8.9664    | 75.0000                     | 5604.0000 (28a)  |
| External Wall 1   | 165.1600             | 33.6700                 | 131.4900               | 0.1500                     | 19.7235   | 110.0000                    | 14463.9000 (29a) |
| Dormer Cheek  | 6.0000               |                         | 6.0000                 | 0.2100                     | 1.2600    | 9.0000                      | 54.0000 (29a)    |
| Cold Roof   | 23.8700              |                         | 23.8700                | 0.0900                     | 2.1483    | 9.0000                      | 214.8300 (30)    |
| Sloping Roof  | 65.8000              | 4.3500                  | 61.4500                | 0.1300                     | 7.9885    | 9.0000                      | 553.0500 (30)    |
| Dormer Roof   | 4.0100               |                         | 4.0100                 | 0.1000                     | 0.4010    | 9.0000                      | 36.0900 (30)     |
| Total net area of external elements Aum(A, m <sup>2</sup> ) |                      |                         | 339.5600               |                            |           |                             | (31)             |

# Full SAP Calculation Printout



|                                     |                      |         |         |                 |
|-------------------------------------|----------------------|---------|---------|-----------------|
| Fabric heat loss, W/K = Sum (A x U) | (26)...(30) + (32) = | 75.7585 |         | (33)            |
| GF                                  | 50.5300              |         | 9.0000  | 454.7700 (32c)  |
| FF                                  | 118.6900             |         | 9.0000  | 1068.2100 (32c) |
| GF Block                            | 54.2100              |         | 75.0000 | 4065.7500 (32c) |
| Internal Floor 1                    | 65.1500              |         | 18.0000 | 1172.7000 (32d) |
| Internal Ceiling 1                  | 65.1500              |         | 9.0000  | 586.3500 (32e)  |

Heat capacity Cm = Sum(A x k) (28)...(30) + (32) + (32a)...(32e) = 28273.6500 (34)  
 Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 202.1423 (35)

|  |         |           |         |
|--|---------|-----------|---------|
| List of Thermal Bridges  |         |           |         |
|  | Length  | Psi-value | Total   |
| K1 Element   |         |           |         |
| E1 Steel lintel with perforated steel base plate                 | 19.3900 | 0.0500    | 0.9695  |
| E3 Sill  | 14.4200 | 0.0240    | 0.3461  |
| E4 Jamb  | 56.1000 | 0.0190    | 1.0659  |
| E5 Ground floor (normal)   | 37.6000 | 0.1170    | 4.3992  |
| E6 Intermediate floor within a dwelling                          | 34.0000 | 0.0010    | 0.0340  |
| E16 Corner (normal)  | 29.2000 | 0.0380    | 1.1096  |
| R1 Head of roof window   | 3.9500  | 0.2400    | 0.9480  |
| R2 Sill of roof window   | 3.9500  | 0.2400    | 0.9480  |
| R3 Jamb of roof window   | 11.0000 | 0.2400    | 2.6400  |
| E10 Eaves (insulation at ceiling level)                          | 5.2100  | 0.0730    | 0.3803  |
| E11 Eaves (insulation at rafter level)                           | 26.0000 | 0.0250    | 0.6500  |
| E12 Gable (insulation at ceiling level)                          | 8.0800  | 0.0960    | 0.7757  |
| E13 Gable (insulation at rafter level)                           | 15.8900 | 0.0600    | 0.9534  |
| R6 Flat ceiling  | 17.9300 | 0.0600    | 1.0758  |
| R7 Flat ceiling (inverted)                                       | 5.6700  | 0.0600    | 0.3402  |
| E17 Corner (inverted - internal area greater than external area) | 10.0000 | -0.0660   | -0.6600 |

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 15.9757 (36)  
 Point Thermal bridges 0.0000  
 Total fabric heat loss (33) + (36) + (36a) = 91.7342 (37)

|   |          |          |          |          |          |          |          |          |          |          |          |               |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |          |          |          |          |          |          |          |          |          |          |               |
| (38)m   | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|   | 27.7466  | 27.3703  | 26.9939  | 25.1123  | 24.7360  | 22.8544  | 22.8544  | 22.4781  | 23.6070  | 24.7360  | 25.4887  | 26.2413 (38)  |
| Heat transfer coeff   | 119.4808 | 119.1044 | 118.7281 | 116.8465 | 116.4702 | 114.5886 | 114.5886 | 114.2122 | 115.3412 | 116.4702 | 117.2228 | 117.9755 (39) |
| Average = Sum(39)m / 12 =   |          |          |          |          |          |          |          |          |          |          |          | 116.7524      |
| HLP   | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|   | 0.8542   | 0.8515   | 0.8488   | 0.8354   | 0.8327   | 0.8193   | 0.8193   | 0.8166   | 0.8246   | 0.8327   | 0.8381   | 0.8435 (40)   |
| HLP (average)   |          |          |          |          |          |          |          |          |          |          |          | 0.8347        |
| Days in mont  | 31       | 28       | 31       | 30       | 31       | 30       | 31       | 31       | 30       | 31       | 30       | 31            |

#### 4. Water heating energy requirements (kWh/year)

|  |          |          |          |          |          |          |          |          |          |          |          |               |   |
|--|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|---|
| Assumed occupancy  |          |          |          |          |          |          |          |          |          |          |          |               | 2.9168 (42)   |
| Hot water usage for mixer showers  |          |          |          |          |          |          |          |          |          |          |          |               |   |
|  | 73.1256  | 72.0267  | 70.4253  | 67.3614  | 65.1003  | 62.5787  | 61.1455  | 62.7347  | 64.4768  | 67.1842  | 70.3139  | 72.8454 (42a) |   |
| Hot water usage for baths  |          |          |          |          |          |          |          |          |          |          |          |               |   |
|  | 31.5696  | 31.1008  | 30.4405  | 29.2232  | 28.3116  | 27.3008  | 26.7549  | 27.4105  | 28.1244  | 29.2059  | 30.4483  | 31.4629 (42b) |   |
| Hot water usage for other uses   |          |          |          |          |          |          |          |          |          |          |          |               |   |
|  | 44.5013  | 42.8831  | 41.2649  | 39.6466  | 38.0284  | 36.4102  | 36.4102  | 38.0284  | 39.6466  | 41.2649  | 42.8831  | 44.5013 (42c) |   |
| Average daily hot water use (litres/day)                                       |          |          |          |          |          |          |          |          |          |          |          |               | 137.1451 (43)   |
| Daily hot water use  | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |   |
|  | 149.1966 | 146.0105 | 142.1307 | 136.2312 | 131.4403 | 126.2897 | 124.3105 | 128.1736 | 132.2478 | 137.6550 | 143.6454 | 148.8097 (44) |   |
| Energy conte   | 236.2909 | 207.9171 | 218.4496 | 186.4937 | 176.9439 | 155.2880 | 150.3428 | 158.7057 | 163.0748 | 186.7965 | 204.6492 | 233.0000 (45) |   |
| Energy content (annual)  |          |          |          |          |          |          |          |          |          |          |          |               | Total = Sum(45)m = 2277.9521                          |
| Distribution loss (46)m = 0.15 x (45)m   |          |          |          |          |          |          |          |          |          |          |          |               |   |
|  | 35.4436  | 31.1876  | 32.7674  | 27.9741  | 26.5416  | 23.2932  | 22.5514  | 23.8059  | 24.4612  | 28.0195  | 30.6974  | 34.9500 (46)  |   |
| Water storage loss:  |          |          |          |          |          |          |          |          |          |          |          |               |   |
| Store volume   |          |          |          |          |          |          |          |          |          |          |          |               | 250.0000 (47)   |
| a) If manufacturer declared loss factor is known (kWh/day):                    |          |          |          |          |          |          |          |          |          |          |          |               | 1.4000 (48)   |
| Temperature factor from Table 2b   |          |          |          |          |          |          |          |          |          |          |          |               | 0.5400 (49)   |
| Enter (49) or (54) in (55)   |          |          |          |          |          |          |          |          |          |          |          |               | 0.7560 (55)   |
| Total storage loss   |          |          |          |          |          |          |          |          |          |          |          |               |   |
|  | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (56)  |   |
| If cylinder contains dedicated solar storage                                   |          |          |          |          |          |          |          |          |          |          |          |               |   |
|  | 23.4360  | 21.1680  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360  | 23.4360  | 22.6800  | 23.4360  | 22.6800  | 23.4360 (57)  |   |
| Primary loss   | 23.2624  | 21.0112  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624 (59)  |   |
| Combi loss   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (61)   |   |
| Total heat required for water heating calculated for each month                |          |          |          |          |          |          |          |          |          |          |          |               |   |
|  | 282.9893 | 250.0963 | 265.1480 | 231.6857 | 223.6423 | 200.4800 | 197.0412 | 205.4041 | 208.2668 | 233.4949 | 249.8412 | 279.6984 (62) |   |
| WWHRS  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63a)  |   |
| PV diverter  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000 (63b) |   |
| Solar input  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63c)  |   |
| FGHRS  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63d)  |   |
| Output from w/h  | 282.9893 | 250.0963 | 265.1480 | 231.6857 | 223.6423 | 200.4800 | 197.0412 | 205.4041 | 208.2668 | 233.4949 | 249.8412 | 279.6984 (64) |   |
| 12Total per year (kWh/year)  |          |          |          |          |          |          |          |          |          |          |          |               | Total per year (kWh/year) = Sum(64)m = 2827.7881 (64) |
| Electric shower(s)   |          |          |          |          |          |          |          |          |          |          |          |               | 2828 (64)   |
|  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (64a)  |   |
| Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = |          |          |          |          |          |          |          |          |          |          |          |               | 0.0000 (64a)  |
| Heat gains from water heating, kWh/month                                       | 115.9254 | 102.8758 | 109.9932 | 98.1627  | 96.1926  | 87.7869  | 87.3477  | 90.1284  | 90.3760  | 99.4686  | 104.1995 | 114.8312 (65) |   |

#### 5. Internal gains (see Table 5 and 5a)

|   |           |           |           |           |           |           |           |           |           |           |           |                |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| Metabolic gains (Table 5), Watts  |           |           |           |           |           |           |           |           |           |           |           |                |
| (66)m   | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec            |
|   | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 156.1869  | 172.9212  | 156.1869  | 161.3931  | 156.1869  | 161.3931  | 156.1869  | 156.1869  | 161.3931  | 156.1869  | 161.3931  | 156.1869 (67)  |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 309.2642  | 312.4734  | 304.3863  | 287.1699  | 265.4373  | 245.0117  | 231.3661  | 228.1569  | 236.2440  | 253.4604  | 275.1930  | 295.6186 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842 (69)   |
| Pumps, fans   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 |           |           |           |           |           |           |           |           |           |           |           |                |
|   | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 (71) |
| Water heating gains (Table 5)   |           |           |           |           |           |           |           |           |           |           |           |                |
|   | 155.8138  | 153.0890  | 147.8403  | 136.3371  | 129.2911  | 121.9262  | 117.4028  | 121.1403  | 125.5222  | 133.6943  | 144.7215  | 154.3430 (72)  |
| Total internal gains  |           |           |           |           |           |           |           |           |           |           |           |                |

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688.0174 705.2361 675.1661 651.6528 617.6678 595.0836 571.7084 572.2367 589.9119 610.0942 648.0602 672.9011 (73)

## 6. Solar gains

| [Jan]       | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | Specific data<br>or Table 6b | Specific data<br>or Table 6c | FF        | Access<br>factor<br>Table 6d | Gains<br>W |           |           |           |          |               |
|-------------|------------|--------------------------------|------------------------------|------------------------------|-----------|------------------------------|------------|-----------|-----------|-----------|----------|---------------|
| North       | 5.9400     | 10.6334                        | 0.3900                       | 0.0000                       | 0.7700    | 18.9677 (74)                 |            |           |           |           |          |               |
| East        | 3.7800     | 19.6403                        | 0.3900                       | 0.0000                       | 0.7700    | 22.2943 (76)                 |            |           |           |           |          |               |
| South       | 6.0800     | 46.7521                        | 0.3900                       | 0.0000                       | 0.7700    | 85.3610 (78)                 |            |           |           |           |          |               |
| North       | 12.6000    | 10.6334                        | 0.5800                       | 0.7000                       | 0.7700    | 37.6966 (74)                 |            |           |           |           |          |               |
| North       | 2.2100     | 15.2954                        | 0.6300                       | 0.7000                       | 1.0000    | 13.4164 (82)                 |            |           |           |           |          |               |
| South       | 2.1400     | 47.0123                        | 0.6300                       | 0.7000                       | 1.0000    | 39.9307 (82)                 |            |           |           |           |          |               |
| Solar gains | 217.6666   | 387.9408                       | 582.2157                     | 817.0540                     | 1009.3419 | 1045.2980                    | 989.6430   | 838.3632  | 661.6690  | 442.0605  | 263.7014 | 184.4206 (83) |
| Total gains | 905.6840   | 1093.1769                      | 1257.3818                    | 1468.7068                    | 1627.0097 | 1640.3816                    | 1561.3514  | 1410.5999 | 1251.5809 | 1052.1547 | 911.7616 | 857.3217 (84) |

## 7. Mean internal temperature (heating season)

| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |                           |         | 21.0000 (85) |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|--------------|
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |                           |         |              |
|   | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct                       | Nov     | Dec          |
| tau   | 65.7327 | 65.9404 | 66.1494 | 67.2146 | 67.4318 | 68.5391 | 68.5391 | 68.7649 | 68.0918 | 67.4318                   | 66.9988 | 66.5714      |
| alpha   | 5.3822  | 5.3960  | 5.4100  | 5.4810  | 5.4955  | 5.5693  | 5.5693  | 5.5843  | 5.5395  | 5.4955                    | 5.4666  | 5.4381       |
| util living area  | 0.9922  | 0.9787  | 0.9431  | 0.8292  | 0.6401  | 0.4443  | 0.3225  | 0.3715  | 0.6160  | 0.8989                    | 0.9811  | 0.9940 (86)  |
| Living  | 19.9424 | 20.1821 | 20.4828 | 20.8101 | 20.9596 | 20.9955 | 20.9994 | 20.9987 | 20.9758 | 20.7427                   | 20.2888 | 19.9079      |
| Non living  | 18.9647 | 19.2692 | 19.6438 | 20.0357 | 20.1918 | 20.2340 | 20.2364 | 20.2385 | 20.2154 | 19.9714                   | 19.4153 | 18.9276      |
| 24 / 16   | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0            |
| 24 / 9  | 3       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 0            |
| 16 / 9  | 28      | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0       | 0                         | 0       | 10           |
| MIT   | 20.4590 | 20.1821 | 20.4828 | 20.8101 | 20.9596 | 20.9955 | 20.9994 | 20.9987 | 20.9758 | 20.7427                   | 20.2888 | 20.0606 (87) |
| Th 2  | 20.2066 | 20.2089 | 20.2112 | 20.2228 | 20.2251 | 20.2367 | 20.2367 | 20.2390 | 20.2320 | 20.2251                   | 20.2204 | 20.2158 (88) |
| util rest of house  | 0.9902  | 0.9737  | 0.9304  | 0.7983  | 0.5938  | 0.3924  | 0.2668  | 0.3105  | 0.5544  | 0.8716                    | 0.9758  | 0.9925 (89)  |
| MIT 2   | 19.7115 | 19.2692 | 19.6438 | 20.0357 | 20.1918 | 20.2340 | 20.2364 | 20.2385 | 20.2154 | 19.9714                   | 19.4153 | 19.1597 (90) |
| Living area fraction  |         |         |         |         |         |         |         |         |         | FLA = Living area / (4) = |         |              |
| MIT   | 19.9596 | 19.5722 | 19.9222 | 20.2927 | 20.4467 | 20.4867 | 20.4896 | 20.4908 | 20.4678 | 20.2274                   | 19.7052 | 19.4587 (92) |
| Temperature adjustment  |         |         |         |         |         |         |         |         |         |                           |         | 0.0000       |
| adjusted MIT  | 19.9596 | 19.5722 | 19.9222 | 20.2927 | 20.4467 | 20.4867 | 20.4896 | 20.4908 | 20.4678 | 20.2274                   | 19.7052 | 19.4587 (93) |

## 8. Space heating requirement

|  | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct           | Nov       | Dec            |
|--|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|---------------|-----------|----------------|
| Utilisation  | 0.9895    | 0.9687    | 0.9250    | 0.8013    | 0.6074    | 0.4095   | 0.2853   | 0.3308   | 0.5738   | 0.8716        | 0.9714    | 0.9906 (94)    |
| Useful gains   | 896.1801  | 1058.9079 | 1163.1323 | 1176.8670 | 988.2012  | 671.7249 | 445.4130 | 466.5619 | 718.1254 | 917.1032      | 885.6784  | 849.3053 (95)  |
| Ext temp.  | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000   | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000       | 7.1000    | 4.2000 (96)    |
| Heat loss rate W   | 1871.0155 | 1747.5205 | 1593.5983 | 1331.2019 | 1018.7242 | 674.5491 | 445.7088 | 467.2154 | 734.4673 | 1121.3019     | 1477.6153 | 1800.1540 (97) |
| Space heating kWh  | 725.2775  | 462.7476  | 320.2667  | 111.1211  | 22.7091   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 151.9239      | 426.1946  | 707.4314 (98a) |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |           |          |          |          |          |               |           | 2927.6720      |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000        | 0.0000    | 0.0000 (98b)   |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |           |          |          |          |          |               |           | 0.0000         |
| Space heating kWh  | 725.2775  | 462.7476  | 320.2667  | 111.1211  | 22.7091   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 151.9239      | 426.1946  | 707.4314 (98c) |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |           |          |          |          |          |               |           | 2927.6720      |
| Space heating per m2   |           |           |           |           |           |          |          |          |          | (98c) / (4) = |           | 20.9314 (99)   |

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

| Fraction of space heat from secondary/supplementary system (Table 11) |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (201)    |
|---|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-----------------|
| Fraction of space heat from main system(s)                            |          |           |           |           |           |           |           |           |           |           |          | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)                      |          |           |           |           |           |           |           |           |           |           |          | 263.8845 (206)  |
| Efficiency of main space heating system 2 (in %)                      |          |           |           |           |           |           |           |           |           |           |          | 0.0000 (207)    |
| Efficiency of secondary/supplementary heating system, %               |          |           |           |           |           |           |           |           |           |           |          | 65.0000 (208)   |
|   | Jan      | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov      | Dec             |
| Space heating requirement   | 725.2775 | 462.7476  | 320.2667  | 111.1211  | 22.7091   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 151.9239  | 426.1946 | 707.4314 (98)   |
| Space heating efficiency (main heating system 1)                      | 263.8845 | 263.8845  | 263.8845  | 263.8845  | 263.8845  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 263.8845  | 263.8845 | 263.8845 (210)  |
| Space heating fuel (main heating system)                              | 274.8466 | 175.3599  | 121.3663  | 42.1098   | 8.6057    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 57.5721   | 161.5080 | 268.0838 (211)  |
| Space heating efficiency (main heating system 2)                      | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (212)    |
| Space heating fuel (main heating system 2)                            | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (213)    |
| Space heating fuel (secondary)  | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (215)    |
| Water heating   |          |           |           |           |           |           |           |           |           |           |          |                 |
| Water heating requirement   | 282.9893 | 250.0963  | 265.1480  | 231.6857  | 223.6423  | 200.4800  | 197.0412  | 205.4041  | 208.2668  | 233.4949  | 249.8412 | 279.6984 (64)   |
| Efficiency of water heater (217)m                                     | 279.3799 | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799  | 279.3799 | 279.3799 (216)  |
| Fuel for water heating, kWh/month                                     | 101.2919 | 89.5184   | 94.9059   | 82.9285   | 80.0495   | 71.7589   | 70.5281   | 73.5214   | 74.5461   | 83.5761   | 89.4271  | 100.1140 (219)  |
| Space cooling fuel requirement (221)m                                 | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000 (221)    |
| Pumps and Fa  | 23.9813  | 21.6606   | 23.9813   | 23.2078   | 23.9813   | 23.2078   | 23.9813   | 23.9813   | 23.2078   | 23.9813   | 23.2078  | 23.9813 (231)   |
| Lighting  | 33.2043  | 26.6377   | 23.9843   | 17.5719   | 13.5731   | 11.0893   | 12.3818   | 16.0943   | 20.9050   | 27.4284   | 30.9804  | 34.1272 (232)   |
| Electricity generated by PVs (Appendix M) (negative quantity) (233a)m | -76.7650 | -105.5200 | -145.2656 | -152.9098 | -158.4855 | -146.0221 | -144.4593 | -137.8796 | -125.3946 | -113.5003 | -82.5432 | -66.5702 (233a) |



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|  |          |              |
|--|----------|--------------|
| Number of open chimneys                            | 0 * 80 = | 0.0000 (6a)  |
| Number of open flues                               | 0 * 20 = | 0.0000 (6b)  |
| Number of chimneys / flues attached to closed fire | 0 * 10 = | 0.0000 (6c)  |
| Number of flues attached to solid fuel boiler      | 0 * 20 = | 0.0000 (6d)  |
| Number of flues attached to other heater           | 0 * 35 = | 0.0000 (6e)  |
| Number of blocked chimneys                         | 0 * 20 = | 0.0000 (6f)  |
| Number of intermittent extract fans                | 4 * 10 = | 40.0000 (7a) |
| Number of passive vents                            | 0 * 10 = | 0.0000 (7b)  |
| Number of flueless gas fires                       | 0 * 40 = | 0.0000 (7c)  |

Air changes per hour

|  |   |                 |             |
|--|---|-----------------|-------------|
| Infiltration due to chimneys, flues and fans         | = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 40.0000 / (5) = | 0.1188 (8)  |
| Pressure test  |   |                 | Yes         |
| Pressure Test Method                                 |   |                 | Blower Door |
| Measured/design AP50                                 |   |                 | 5.0000 (17) |
| Infiltration rate                                    |   |                 | 0.3688 (18) |
| Number of sides sheltered                            |   |                 | 2 (19)      |
| Shelter factor                                       | (20) = 1 - [0.075 x (19)] =                           |                 | 0.8500 (20) |
| Infiltration rate adjusted to include shelter factor | (21) = (18) x (20) =                                  |                 | 0.3135 (21) |

|                 |        |        |        |        |        |        |        |        |        |        |        |        |       |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------|
| Wind speed      | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec    |       |
|                 | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 | (22)  |
| Wind factor     | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 | (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |        |       |
|                 | 0.3997 | 0.3919 | 0.3840 | 0.3448 | 0.3370 | 0.2978 | 0.2978 | 0.2900 | 0.3135 | 0.3370 | 0.3527 | 0.3684 | (22b) |
| Effective ac    | 0.5799 | 0.5768 | 0.5737 | 0.5595 | 0.5568 | 0.5443 | 0.5443 | 0.5420 | 0.5491 | 0.5568 | 0.5622 | 0.5678 | (25)  |

### 3. Heat losses and heat loss parameter

| Element  | Gross<br>m2 | Openings<br>m2 | NetArea<br>m2 | U-value<br>W/m2K | A x U<br>W/K | K-value<br>kJ/m2K | A x K<br>kJ/K |
|--|-------------|----------------|---------------|------------------|--------------|-------------------|---------------|
| TER Opaque door                                |             |                | 3.1500        | 1.0000           | 3.1500       |                   | (26)          |
| TER Semi-glazed door                           |             |                | 2.1200        | 1.0000           | 2.1200       |                   | (26a)         |
| TER Opening Type (Uw = 1.20)                   |             |                | 25.7700       | 1.1450           | 29.5076      |                   | (27)          |
| Front  |             |                | 1.2700        | 1.4151           | 1.7972       |                   | (27a)         |
| Side   |             |                | 0.6700        | 1.4151           | 0.9481       |                   | (27a)         |
| Rear   |             |                | 2.0000        | 1.4151           | 2.8302       |                   | (27a)         |
| Ground Floor                                   |             |                | 74.7200       | 0.1300           | 9.7136       |                   | (28a)         |
| External Wall 1                                | 165.1600    | 31.0400        | 134.1200      | 0.1800           | 24.1416      |                   | (29a)         |
| Dormer Cheek                                   | 6.0000      |                | 6.0000        | 0.1800           | 1.0800       |                   | (29a)         |
| Cold Roof                                      | 23.8700     |                | 23.8700       | 0.1100           | 2.6257       |                   | (30)          |
| Sloping Roof                                   | 65.8000     | 3.9400         | 61.8600       | 0.1100           | 6.8046       |                   | (30)          |
| Dormer Roof                                    | 4.0100      |                | 4.0100        | 0.1100           | 0.4411       |                   | (30)          |
| Total net area of external elements Aum(A, m2) |             |                | 339.5600      |                  |              |                   | (31)          |
| Fabric heat loss, W/K = Sum (A x U)            |             |                |               |                  | 85.1597      |                   | (33)          |

Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K 202.1423 (35)

List of Thermal Bridges

| K1 Element   | Length  | Psi-value | Total   |
|--|---------|-----------|---------|
| E1 Steel lintel with perforated steel base plate                 | 19.3900 | 0.0500    | 0.9695  |
| E3 Sill  | 14.4200 | 0.0500    | 0.7210  |
| E4 Jamb  | 56.1000 | 0.0500    | 2.8050  |
| E5 Ground floor (normal)   | 37.6000 | 0.1600    | 6.0160  |
| E6 Intermediate floor within a dwelling                          | 34.0000 | 0.0000    | 0.0000  |
| E16 Corner (normal)  | 29.2000 | 0.0900    | 2.6280  |
| R1 Head of roof window   | 3.9500  | 0.0800    | 0.3160  |
| R2 Sill of roof window   | 3.9500  | 0.0600    | 0.2370  |
| R3 Jamb of roof window   | 11.0000 | 0.0800    | 0.8800  |
| E10 Eaves (insulation at ceiling level)                          | 5.2100  | 0.0600    | 0.3126  |
| E11 Eaves (insulation at rafter level)                           | 26.0000 | 0.0400    | 1.0400  |
| E12 Gable (insulation at ceiling level)                          | 8.0800  | 0.0600    | 0.4848  |
| E13 Gable (insulation at rafter level)                           | 15.8900 | 0.0800    | 1.2712  |
| R6 Flat ceiling  | 17.9300 | 0.0600    | 1.0758  |
| R7 Flat ceiling (inverted)                                       | 5.6700  | 0.0400    | 0.2268  |
| E17 Corner (inverted - internal area greater than external area) | 10.0000 | -0.0900   | -0.9000 |

Thermal bridges (Sum(L x Psi) calculated using Appendix K) 18.0837 (36)  
 Point Thermal bridges (36a) = 0.0000  
 Total fabric heat loss (33) + (36) + (36a) = 103.2434 (37)

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

|                           |          |          |          |          |          |          |          |          |          |          |          |          |
|---------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|
| (38)m                     | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec      |
|                           | 64.4209  | 64.0763  | 63.7385  | 62.1519  | 61.8551  | 60.4733  | 60.4733  | 60.2174  | 61.0055  | 61.8551  | 62.4556  | 63.0834  |
| Heat transfer coeff       | 167.6643 | 167.3197 | 166.9819 | 165.3954 | 165.0985 | 163.7167 | 163.7167 | 163.4608 | 164.2489 | 165.0985 | 165.6990 | 166.3268 |
| Average = Sum(39)m / 12 = |          |          |          |          |          |          |          |          |          |          |          | 165.3939 |

|               |        |        |        |        |        |        |        |        |        |        |        |        |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| HLP           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec    |
|               | 1.1987 | 1.1963 | 1.1938 | 1.1825 | 1.1804 | 1.1705 | 1.1705 | 1.1687 | 1.1743 | 1.1804 | 1.1847 | 1.1892 |
| HLP (average) |        |        |        |        |        |        |        |        |        |        |        | 1.1825 |
| Days in mont  | 31     | 28     | 31     | 30     | 31     | 30     | 31     | 31     | 30     | 31     | 30     | 31     |

### 4. Water heating energy requirements (kWh/year)

|   |          |          |          |          |          |          |          |          |          |          |          |          |                |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
| Assumed occupancy   |          |          |          |          |          |          |          |          |          |          |          |          | 2.9168 (42)    |
| Hot water usage for mixer showers                           |          |          |          |          |          |          |          |          |          |          |          |          |                |
|   | 73.1256  | 72.0267  | 70.4253  | 67.3614  | 65.1003  | 62.5787  | 61.1455  | 62.7347  | 64.4768  | 67.1842  | 70.3139  | 72.8454  | (42a)          |
| Hot water usage for baths                                   |          |          |          |          |          |          |          |          |          |          |          |          |                |
|   | 31.5696  | 31.1008  | 30.4405  | 29.2232  | 28.3116  | 27.3008  | 26.7549  | 27.4105  | 28.1244  | 29.2059  | 30.4483  | 31.4629  | (42b)          |
| Hot water usage for other uses                              |          |          |          |          |          |          |          |          |          |          |          |          |                |
|   | 44.5013  | 42.8831  | 41.2649  | 39.6466  | 38.0284  | 36.4102  | 36.4102  | 38.0284  | 39.6466  | 41.2649  | 42.8831  | 44.5013  | (42c)          |
| Average daily hot water use (litres/day)                    |          |          |          |          |          |          |          |          |          |          |          |          | 137.1451 (43)  |
| Daily hot water use   | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec      |                |
|   | 149.1966 | 146.0105 | 142.1307 | 136.2312 | 131.4403 | 126.2897 | 124.3105 | 128.1736 | 132.2478 | 137.6550 | 143.6454 | 148.8097 |                |
| Energy conte  | 236.2909 | 207.9171 | 218.4496 | 186.4937 | 176.9439 | 155.2880 | 150.3428 | 158.7057 | 163.0748 | 186.7965 | 204.6492 | 233.0000 |                |
| Energy content (annual)                                     |          |          |          |          |          |          |          |          |          |          |          |          | 2277.9521 (45) |
| Distribution loss (46)m = 0.15 x (45)m                      |          |          |          |          |          |          |          |          |          |          |          |          |                |
|   | 35.4436  | 31.1876  | 32.7674  | 27.9741  | 26.5416  | 23.2932  | 22.5514  | 23.8059  | 24.4612  | 28.0195  | 30.6974  | 34.9500  | (46)           |
| Water storage loss:   |          |          |          |          |          |          |          |          |          |          |          |          |                |
| Store volume  |          |          |          |          |          |          |          |          |          |          |          |          | 250.0000 (47)  |
| a) If manufacturer declared loss factor is known (kWh/day): |          |          |          |          |          |          |          |          |          |          |          |          | 1.8903 (48)    |

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|   |          |          |          |          |          |          |          |          |          |          |          |                |
|---|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
| Temperature factor from Table 2b                                |          |          |          |          |          |          |          |          |          |          |          | 0.5400 (49)    |
| Enter (49) or (54) in (55)                                      |          |          |          |          |          |          |          |          |          |          |          | 1.0208 (55)    |
| Total storage loss  | 31.6444  | 28.5820  | 31.6444  | 30.6236  | 31.6444  | 30.6236  | 31.6444  | 31.6444  | 30.6236  | 31.6444  | 30.6236  | 31.6444 (56)   |
| If cylinder contains dedicated solar storage                    | 31.6444  | 28.5820  | 31.6444  | 30.6236  | 31.6444  | 30.6236  | 31.6444  | 31.6444  | 30.6236  | 31.6444  | 30.6236  | 31.6444 (57)   |
| Primary loss  | 23.2624  | 21.0112  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624 (59)   |
| Combi loss  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (61)    |
| Total heat required for water heating calculated for each month | 291.1977 | 257.5103 | 273.3564 | 239.6293 | 231.8507 | 208.4236 | 205.2496 | 213.6125 | 216.2104 | 241.7033 | 257.7848 | 287.9068 (62)  |
| WWHRS   | -33.4300 | -29.5657 | -30.9595 | -25.6357 | -23.8916 | -20.4442 | -19.1632 | -20.3781 | -21.1523 | -24.9363 | -28.2498 | -32.8109 (63a) |
| PV diverter   | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000 (63b)  |
| Solar input   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63c)   |
| FGHRS   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63d)   |
| Output from w/h   | 257.7677 | 227.9446 | 242.3968 | 213.9936 | 207.9591 | 187.9794 | 186.0864 | 193.2344 | 195.0580 | 216.7670 | 229.5350 | 255.0959 (64)  |
| 12Total per year (kWh/year)                                     |          |          |          |          |          |          |          |          |          |          |          | 2613.8179 (64) |
| Electric shower(s)  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (64a)   |
| Heat gains from water heating, kWh/month                        | 122.4922 | 108.8070 | 116.5599 | 104.5176 | 102.7593 | 94.1417  | 93.9144  | 96.6951  | 96.7308  | 106.0353 | 110.5543 | 121.3979 (65)  |

## 5. Internal gains (see Table 5 and 5a)

|   |           |           |           |           |           |           |           |           |           |           |           |                |
|---|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| Metabolic gains (Table 5), Watts  | Jan       | Feb       | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov       | Dec            |
| (66)m   | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419  | 145.8419 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 156.0880  | 172.8117  | 156.0880  | 161.2909  | 156.0880  | 161.2909  | 156.0880  | 156.0880  | 161.2909  | 156.0880  | 161.2909  | 156.0880 (67)  |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 309.2642  | 312.4734  | 304.3863  | 287.1699  | 265.4373  | 245.0117  | 231.3661  | 228.1569  | 236.2440  | 253.4604  | 275.1930  | 295.6186 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842   | 37.5842 (69)   |
| Pumps, fans   | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 3.0000    | 3.0000    | 3.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 | -116.6735 (71) |
| Water heating gains (Table 5)   | 164.6400  | 161.9152  | 156.6666  | 145.1634  | 138.1173  | 130.7524  | 126.2291  | 129.9665  | 134.3484  | 142.5205  | 153.5477  | 163.1692 (72)  |
| Total internal gains  | 699.7447  | 716.9528  | 686.8934  | 663.3767  | 629.3951  | 603.8075  | 580.4357  | 580.9640  | 598.6359  | 621.8215  | 659.7842  | 684.6284 (73)  |

## 6. Solar gains

|             |          |           |            |               |               |           |              |           |           |           |          |               |
|-------------|----------|-----------|------------|---------------|---------------|-----------|--------------|-----------|-----------|-----------|----------|---------------|
| [Jan]       |          | Area      | Solar flux | g             | FF            | Access    | Gains        |           |           |           |          |               |
|             |          | m2        | Table 6a   | Specific data | Specific data | factor    | W            |           |           |           |          |               |
|             |          |           | W/m2       | or Table 6b   | or Table 6c   | Table 6d  |              |           |           |           |          |               |
| North       |          | 16.8200   | 10.6334    | 0.6300        | 0.7000        | 0.7700    | 54.6600 (74) |           |           |           |          |               |
| East        |          | 3.4300    | 19.6403    | 0.6300        | 0.7000        | 0.7700    | 20.5880 (76) |           |           |           |          |               |
| South       |          | 5.5200    | 46.7521    | 0.6300        | 0.7000        | 0.7700    | 78.8700 (78) |           |           |           |          |               |
| North       |          | 2.0000    | 15.2954    | 0.6300        | 0.7000        | 1.0000    | 12.1415 (82) |           |           |           |          |               |
| South       |          | 1.9400    | 47.0123    | 0.6300        | 0.7000        | 1.0000    | 36.1988 (82) |           |           |           |          |               |
| Solar gains | 202.4583 | 361.1084  | 542.7393   | 763.0179      | 943.7851      | 977.9070  | 925.6386     | 783.3694  | 617.2492  | 411.6891  | 245.3237 | 171.5060 (83) |
| Total gains | 902.2029 | 1078.0611 | 1229.6327  | 1426.3946     | 1573.1803     | 1581.7146 | 1506.0743    | 1364.3333 | 1215.8850 | 1033.5105 | 905.1079 | 856.1344 (84) |

## 7. Mean internal temperature (heating season)

|   |         |         |         |         |         |         |         |         |                           |         |         |              |
|---|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |                           |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep                       | Oct     | Nov     | Dec          |
| tau   | 46.8424 | 46.9388 | 47.0338 | 47.4850 | 47.5703 | 47.9718 | 47.9718 | 48.0469 | 47.8164                   | 47.5703 | 47.3979 | 47.2190      |
| alpha   | 4.1228  | 4.1293  | 4.1356  | 4.1657  | 4.1714  | 4.1981  | 4.1981  | 4.2031  | 4.1878                    | 4.1714  | 4.1599  | 4.1479       |
| util living area  | 0.9936  | 0.9862  | 0.9692  | 0.9152  | 0.7967  | 0.6175  | 0.4668  | 0.5300  | 0.7778                    | 0.9484  | 0.9874  | 0.9949 (86)  |
| MIT   | 19.2988 | 19.5419 | 19.9000 | 20.3759 | 20.7469 | 20.9360 | 20.9844 | 20.9740 | 20.8315                   | 20.3389 | 19.7365 | 19.2604 (87) |
| Th 2  | 19.9210 | 19.9230 | 19.9249 | 19.9340 | 19.9357 | 19.9437 | 19.9437 | 19.9452 | 19.9406                   | 19.9357 | 19.9323 | 19.9287 (88) |
| util rest of house  | 0.9919  | 0.9825  | 0.9605  | 0.8913  | 0.7438  | 0.5315  | 0.3602  | 0.4180  | 0.7018                    | 0.9288  | 0.9833  | 0.9934 (89)  |
| MIT 2   | 17.9437 | 18.2541 | 18.7073 | 19.2970 | 19.7174 | 19.9043 | 19.9379 | 19.9345 | 19.8184                   | 19.2664 | 18.5103 | 17.8998 (90) |
| Living area fraction  |         |         |         |         |         |         |         |         | FLA = Living area / (4) = |         |         | 0.3319 (91)  |
| MIT   | 18.3934 | 18.6815 | 19.1032 | 19.6550 | 20.0591 | 20.2467 | 20.2852 | 20.2795 | 20.1546                   | 19.6223 | 18.9172 | 18.3513 (92) |
| Temperature adjustment  |         |         |         |         |         |         |         |         |                           |         |         | 0.0000       |
| adjusted MIT  | 18.3934 | 18.6815 | 19.1032 | 19.6550 | 20.0591 | 20.2467 | 20.2852 | 20.2795 | 20.1546                   | 19.6223 | 18.9172 | 18.3513 (93) |

## 8. Space heating requirement

|  |           |           |           |           |           |          |          |          |          |           |           |                 |              |
|--|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|-----------|-----------------|--------------|
| Utilisation  | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct       | Nov       | Dec             |              |
|  | 0.9882    | 0.9765    | 0.9519    | 0.8839    | 0.7505    | 0.5573   | 0.3954   | 0.4547   | 0.7188   | 0.9215    | 0.9779    | 0.9904 (94)     |              |
| Useful gains   | 891.5957  | 1052.6893 | 1170.4985 | 1260.8296 | 1180.6790 | 881.5289 | 595.4935 | 620.3313 | 873.9517 | 952.3773  | 885.0932  | 847.8792 (95)   |              |
| Ext temp.  | 4.3000    | 4.9000    | 6.5000    | 8.9000    | 11.7000   | 14.6000  | 16.6000  | 16.4000  | 14.1000  | 10.6000   | 7.1000    | 4.2000 (96)     |              |
| Heat loss rate W   | 2362.9583 | 2305.9121 | 2104.4987 | 1778.8334 | 1380.0742 | 924.4641 | 603.3305 | 634.1456 | 994.4645 | 1489.5688 | 1958.1065 | 2353.7433 (97)  |              |
| Space heating kWh  | 1094.6937 | 842.1657  | 694.8962  | 372.9627  | 148.3501  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 399.6705  | 772.5696  | 1120.3629 (98a) |              |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |           |          |          |          |          |           |           | 5445.6714       |              |
| Solar heating kWh  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000 (98b)    |              |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |           |          |          |          |          |           |           | 0.0000          |              |
| Space heating kWh  | 1094.6937 | 842.1657  | 694.8962  | 372.9627  | 148.3501  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 399.6705  | 772.5696  | 1120.3629 (98c) |              |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |           |          |          |          |          |           |           | 5445.6714       |              |
| Space heating per m2   |           |           |           |           |           |          |          |          |          |           |           | (98c) / (4) =   | 38.9338 (99) |



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

|  | Jan       | Feb      | Mar       | Apr       | May       | Jun       | Jul       | Aug       | Sep       | Oct       | Nov      | Dec       |                  |
|--|-----------|----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------|-----------|------------------|
| Fraction of space heat from secondary/supplementary system (Table 11)                                |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (201)     |
| Fraction of space heat from main system(s)   |           |          |           |           |           |           |           |           |           |           |          |           | 1.0000 (202)     |
| Efficiency of main space heating system 1 (in %)   |           |          |           |           |           |           |           |           |           |           |          |           | 92.3000 (206)    |
| Efficiency of main space heating system 2 (in %)   |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (207)     |
| Efficiency of secondary/supplementary heating system, %  |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (208)     |
| Space heating requirement  | 1094.6937 | 842.1657 | 694.8962  | 372.9627  | 148.3501  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 399.6705  | 772.5696 | 1120.3629 | (98)             |
| Space heating efficiency (main heating system 1)   | 92.3000   | 92.3000  | 92.3000   | 92.3000   | 92.3000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 92.3000   | 92.3000  | 92.3000   | (210)            |
| Space heating fuel (main heating system)   | 1186.0170 | 912.4222 | 752.8669  | 404.0766  | 160.7260  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 433.0125  | 837.0201 | 1213.8276 | (211)            |
| Space heating efficiency (main heating system 2)   | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (212)            |
| Space heating fuel (main heating system 2)   | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (213)            |
| Space heating fuel (secondary)   | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (215)            |
| Water heating  |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| Water heating requirement  | 257.7677  | 227.9446 | 242.3968  | 213.9936  | 207.9591  | 187.9794  | 186.0864  | 193.2344  | 195.0580  | 216.7670  | 229.5350 | 255.0959  | (64)             |
| Efficiency of water heater (217)m  | 86.9314   | 86.7167  | 86.2834   | 85.2929   | 83.3157   | 79.8000   | 79.8000   | 79.8000   | 79.8000   | 85.4126   | 86.5638  | 86.9806   | (216)            |
| Fuel for water heating, kWh/month  | 296.5186  | 262.8611 | 280.9311  | 250.8926  | 249.6036  | 235.5631  | 233.1910  | 242.1484  | 244.4336  | 253.7881  | 265.1628 | 293.2789  | (219)            |
| Space cooling fuel requirement   |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| (221)m   | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (221)            |
| Pumps and Fa   | 7.3041    | 6.5973   | 7.3041    | 7.0685    | 7.3041    | 7.0685    | 7.3041    | 7.3041    | 7.0685    | 7.3041    | 7.0685   | 7.3041    | (231)            |
| Lighting   | 32.4320   | 26.0182  | 23.4265   | 17.1632   | 13.2574   | 10.8314   | 12.0938   | 15.7200   | 20.4187   | 26.7905   | 30.2598  | 33.3334   | (232)            |
| Electricity generated by PVs (Appendix M) (negative quantity)  |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| (233a)m  | -64.5012  | -88.3078 | -123.2821 | -134.4423 | -141.4661 | -130.6902 | -128.9212 | -123.2909 | -113.0219 | -98.8105  | -69.9058 | -56.0650  | (233a)           |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| (234a)m  | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (234a)           |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| (235a)m  | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (235a)           |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| (235c)m  | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (235c)           |
| Electricity generated by PVs (Appendix M) (negative quantity)  |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| (233b)m  | -44.9036  | -93.3399 | -183.5474 | -272.9334 | -358.3617 | -359.2737 | -355.1814 | -301.9989 | -222.9629 | -132.7226 | -59.6853 | -35.6075  | (233b)           |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| (234b)m  | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (234b)           |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| (235b)m  | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (235b)           |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| (235d)m  | 0.0000    | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000    | (235d)           |
| Annual totals kWh/year   |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| Space heating fuel - main system 1   |           |          |           |           |           |           |           |           |           |           |          |           | 5899.9690 (211)  |
| Space heating fuel - main system 2   |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (213)     |
| Space heating fuel - secondary   |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (215)     |
| Efficiency of water heater   |           |          |           |           |           |           |           |           |           |           |          |           | 79.8000          |
| Water heating fuel used  |           |          |           |           |           |           |           |           |           |           |          |           | 3108.3729 (219)  |
| Space cooling fuel   |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (221)     |
| Electricity for pumps and fans:  |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| Total electricity for the above, kWh/year  |           |          |           |           |           |           |           |           |           |           |          |           | 86.0000 (231)    |
| Electricity for lighting (calculated in Appendix L)  |           |          |           |           |           |           |           |           |           |           |          |           | 261.7448 (232)   |
| Energy saving/generation technologies (Appendices M ,N and Q)  |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| PV generation  |           |          |           |           |           |           |           |           |           |           |          |           | -3693.2232 (233) |
| Wind generation  |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (234)     |
| Hydro-electric generation (Appendix N)   |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (235a)    |
| Electricity generated - Micro CHP (Appendix N)   |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (235)     |
| Appendix Q - special features  |           |          |           |           |           |           |           |           |           |           |          |           |                  |
| Energy saved or generated  |           |          |           |           |           |           |           |           |           |           |          |           | -0.0000 (236)    |
| Energy used  |           |          |           |           |           |           |           |           |           |           |          |           | 0.0000 (237)     |
| Total delivered energy for all uses  |           |          |           |           |           |           |           |           |           |           |          |           | 5662.8635 (238)  |

## 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|   | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |
|---|-----------------|----------------------------|-----------------------|
| Space heating - main system 1                 | 5899.9690       | 0.2100                     | 1238.9935 (261)       |
| Total CO2 associated with community systems   |                 |                            | 0.0000 (373)          |
| Water heating (other fuel)                    | 3108.3729       | 0.2100                     | 652.7583 (264)        |
| Space and water heating                       |                 |                            | 1891.7518 (265)       |
| Pumps, fans and electric keep-hot             | 86.0000         | 0.1387                     | 11.9293 (267)         |
| Energy for lighting                           | 261.7448        | 0.1443                     | 37.7779 (268)         |
| Energy saving/generation technologies         |                 |                            |                       |
| PV Unit electricity used in dwelling          | -1272.7050      | 0.1352                     | -172.1268             |
| PV Unit electricity exported                  | -2420.5182      | 0.1262                     | -305.4327             |
| Total   |                 |                            | -477.5595 (269)       |
| Total CO2, kg/year                            |                 |                            | 1463.8995 (272)       |
| EPC Target Carbon Dioxide Emission Rate (TER) |                 |                            | 10.4700 (273)         |

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

|   | Energy kWh/year | Primary energy factor kg CO2/kWh | Primary energy kWh/year |
|---|-----------------|----------------------------------|-------------------------|
| Space heating - main system 1               | 5899.9690       | 1.1300                           | 6666.9650 (275)         |
| Total CO2 associated with community systems |                 |                                  | 0.0000 (473)            |
| Water heating (other fuel)                  | 3108.3729       | 1.1300                           | 3512.4614 (278)         |
| Space and water heating                     |                 |                                  | 10179.4264 (279)        |
| Pumps, fans and electric keep-hot           | 86.0000         | 1.5128                           | 130.1008 (281)          |
| Energy for lighting                         | 261.7448        | 1.5338                           | 401.4729 (282)          |
| Energy saving/generation technologies       |                 |                                  |                         |
| PV Unit electricity used in dwelling        | -1272.7050      | 1.4999                           | -1908.9032              |
| PV Unit electricity exported                | -2420.5182      | 0.4632                           | -1121.1779              |

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Total  
Total Primary energy kWh/year  
Target Primary Energy Rate (TPER)

-3030.0811 (283)  
7680.9190 (286)  
54.9100 (287)