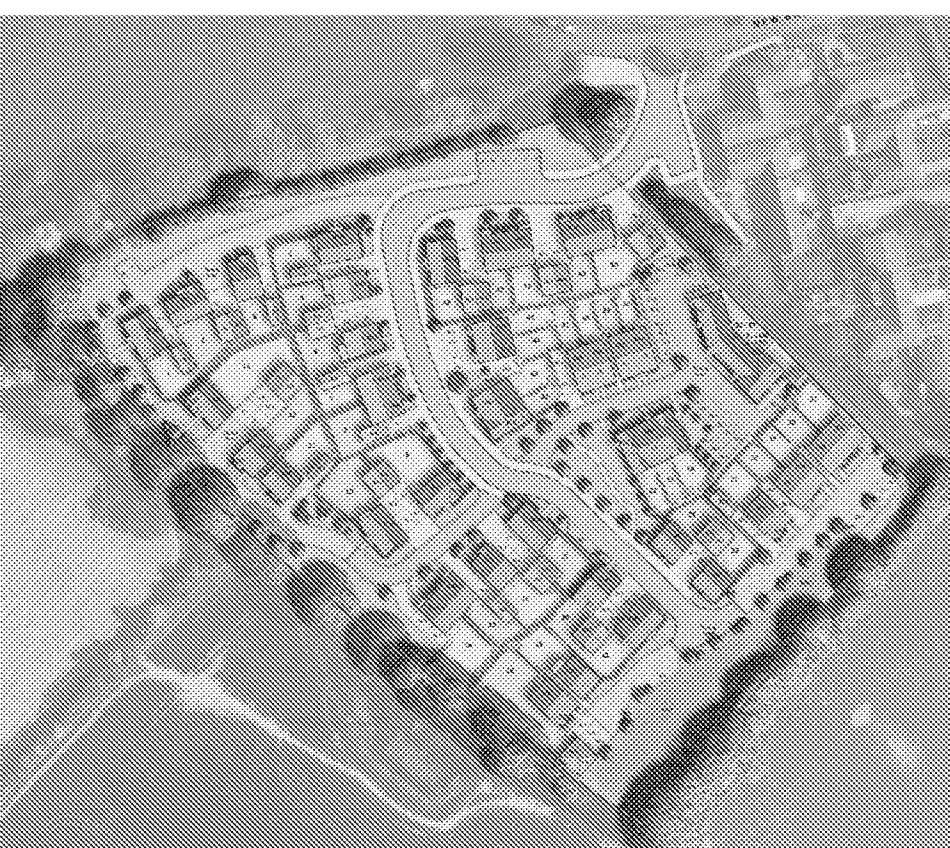




NEW BARN LANE, BERSTED, WEST SUSSEX

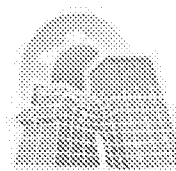


## ENERGY STATEMENT

16<sup>th</sup> September 2019

SEC/ds/sus/es- 3659

ARUN DISTRICT COUNCIL BE/91/20/DOC



**Southern Energy**  
Consultants  
Energy & Sustainability Solutions

### *About Southern Energy Consultants Ltd*

*Southern Energy Consultants Ltd are a construction consultancy specialising in sustainability, energy conservation, the application of renewable technologies and statutory utilities infrastructure design and management. As a consultancy we do not sell or have financial interest in any products so are able to take an objective view of developments to assist developers with incorporating cost effective and practical solutions.*

*Our services include Planning Energy Statements, energy calculations for Building Regulation compliance, Code for Sustainable Homes assessments and utilities design and management. Our team of consultants include registered SAP, SBEM and Code for Sustainable Homes assessors, Planning Specialists, Renewable Energy Specialists, CAD Specialist, Utilities Specialists and Civil Engineers.*

*Within SEC Ltd we have over 25 years experience working with and for National Developers, Construction and Design and Build Contractors we apply our expertise not only to assist with developers understanding of new energy and sustainability obligations but also in a way that ensures that the needs and responsibilities of all stakeholders are wholly respected.*

Report prepared by:  
QA:

David Cook  
Steve Smith

16th Septmber 2019

Report type:

Planning Condition: Supporting Document

## Contents

|                 |                                                                                                                        |    |
|-----------------|------------------------------------------------------------------------------------------------------------------------|----|
| <b>1.0</b>      | Introduction                                                                                                           | 3  |
| <b>2.0</b>      | Calculation of Baseline Carbon Dioxide Emissions and Feasibility Study of Renewable Energy and Low Carbon Technologies | 5  |
| <b>3.0</b>      | Best Practice Energy Efficiency Proposals                                                                              | 12 |
| <b>4.0</b>      | Conclusion                                                                                                             | 16 |
| <b>Appendix</b> |                                                                                                                        | 17 |
|                 | SAP Calculation Examples (including best practice energy efficiency measures):                                         |    |
|                 | Type Chandler – Plot 8                                                                                                 |    |
|                 | Type Carver – Plot 11                                                                                                  |    |

## 1.0 Introduction

- 1.1 This Energy Statement has been commissioned by Bellway Homes (the Applicant) and carried out by Southern Energy Consultants to respond to planning condition 10 related to the planning consent (Ref: APP/C3810/V/17/3166900, dated 12<sup>th</sup> February 2018) for their development at New Barn Lane, North Bersted. The overall development is located within the Arun District Council authority boundary and includes the construction of 50 residential dwellings of mixed type and tenure, together with provision of landscaping, amenity space, car and cycle parking, and various infrastructure works.
- 1.2 This Statement first details the contents of condition 10 and its underpinning policy, before, in subsequent Sections, proceeding to detail the Applicant's comprehensive response.

### Planning Condition 10

- 1.3 Planning Condition 10 states the following: *"At least 10% of the energy supply of the development shall be secured from decentralised and renewable or low-carbon energy sources or equivalent fabric first standards that would secure a 10% reduction in energy use. Details and a timetable of how this is to be achieved, including details of physical works on site, shall be submitted to and approved in writing by the local planning authority [as part of the reserved matters submissions required by condition 1]. The approved details shall be implemented in accordance with the approved timetable and retained as operational thereafter."*
- 1.4 Condition 10 is justified through Policy ECC SP2 (Energy and Climate Change Mitigation) of Arun District Council's Local Plan (2014). This policy requires all major developments of 10 or more dwellings to incorporate decentralised, renewable and low carbon energy supply systems, which must be responsible for producing at least 10% of the total predicted energy requirements from renewable or low carbon energy generation on site.

### Summary of Requirements

- 1.5 The aim of this Statement is to set out the Applicant's approach which will comply with Policy ME4 and better the lifetime emissions reductions requirements achieved by

delivering a 10% reduction in regulated emissions through the installation of renewable or low carbon technologies. In so doing, the Applicant will demonstrate how the “equivalent fabric first standards” permitted by Condition 10 will deliver greater reductions in emissions than an alternative approach

- 1.6 In order to arrive at the optimal strategy for the New Barn Lane development, Southern Energy Consultants have carried out Standard Assessment Procedure (SAP) calculations on the proposed dwellings, using Government approved Elmhurst software, and detailed examples of the analysis are appended to this Energy Statement. A feasibility study has then been carried out to consider the potential for incorporating renewable or low carbon technologies into development.
- 1.7 Section 2 of this Statement calculates the baseline emissions for the development. These are the carbon dioxide emissions equivalent to the regulatory standard set by Part L1a of 2013 Building Regulations, encompassing the sources of space heating, hot water and fixed electrical items. The potential suitability of various renewable and low carbon energy sources, including district heating, is then discussed. Section 3 then sets out the additional best practice energy efficiency measures that the Applicant proposes to incorporate in order to better the emissions reduction standard required by Condition 10.

## 2.0 Calculation of Baseline Carbon Dioxide Emissions and Feasibility Study of Renewable Energy and Low Carbon Technologies

### Introduction

- 2.1 The aims of Section 2 are to (a) demonstrate the approach that the Applicant could take to delivering compliance with Part L1a of Building Regulations (2013) through the adoption of best practice energy efficiency measures, and (b) consider the suitability of various renewable energy and low carbon technologies for delivering per annum reductions of at least 10% in carbon dioxide emissions beyond the baseline standard.

### Calculation of Theoretical Baseline

- 2.2 In order that an energy assessment can be conducted, the theoretical baseline for carbon dioxide emissions first has to be calculated for the range of twelve proposed dwelling types. The estimated regulated carbon dioxide emissions for the dwellings have been calculated using SAP (2012) methodology and the most up-to-date Elmhurst software. SAP calculates the regulated carbon dioxide emissions associated with space heating, hot water and fixed electrical items. Table 1 below provides a breakdown of the theoretical carbon dioxide emissions for the development (assuming no renewable/low carbon technologies were installed), which total **74,168 kgCO<sub>2</sub>/year**.

**Table 1: Baseline Carbon Dioxide Emissions for the New Barn Lane Park Development**

| DWELLING TYPE            | REGULATED CARBON DIOXIDE EMISSIONS (kgCO <sub>2</sub> /yr) | NUMBER OF DWELLINGS | TOTAL EMISSIONS PER TYPE (kgCO <sub>2</sub> /yr) |
|--------------------------|------------------------------------------------------------|---------------------|--------------------------------------------------|
| <b>Private dwellings</b> |                                                            |                     |                                                  |
| Cooper                   | 1,244                                                      | 4                   | 4,976                                            |
| Chandler                 | 1,496                                                      | 10                  | 14,960                                           |
| Carver                   | 1,522                                                      | 3                   | 4,566                                            |
| Mason                    | 1,576                                                      | 4                   | 6,304                                            |

|                             |       |           |               |
|-----------------------------|-------|-----------|---------------|
| Scrivener                   | 1,712 | 5         | 8,560         |
| Milliner                    | 1,766 | 6         | 10,596        |
| Bowyer                      | 1,878 | 3         | 5,634         |
| <b>Private sub-total</b>    |       | <b>35</b> | <b>55,596</b> |
| <b>Affordable dwellings</b> |       |           |               |
| 1B Flat                     | 990   | 5         | 4,950         |
| 2B Flat                     | 1,186 | 1         | 1,186         |
| Baker                       | 1,312 | 5         | 6,560         |
| Ploughwright                | 1,455 | 3         | 4,365         |
| Cartographer                | 1,511 | 1         | 1,511         |
| <b>Affordable sub-total</b> |       | <b>15</b> | <b>18,572</b> |
| <b>TOTAL</b>                |       | <b>50</b> | <b>74,168</b> |

### Applicant's Measures to Meet the Baseline Scenario

- 2.3 In addition to the passive solar gains secured by orientating the majority of dwelling living areas in a southerly, south-westerly or south-easterly direction and maximising opportunities to increase the area of glazing on these elevations, the Applicant would comply with the baseline scenario by meeting the fabric performance for thermal elements (walls, roofs, floors and glazing) listed in Table 2 below. The fabric performance standards are in all cases superior to the limiting standards set by Part L1a of Building Regulations (2013).

**Table 2: Fabric Performance Standards to Comply with Baseline Scenario**

| Thermal Element     | Maximum Area-Weighted U-value (W/m <sup>2</sup> K) Allowable Under 2013 Building Regulations | Applicant's Proposed U-value (W/m <sup>2</sup> K) required to Meet 2013 Building Regulations Baseline | % Improvement on 2013 Allowable U-Value Standard |
|---------------------|----------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| Main external walls | 0.30                                                                                         | 0.24                                                                                                  | 20.00                                            |

|                |      |      |       |
|----------------|------|------|-------|
| Roof (joists)  | 0.20 | 0.10 | 50.00 |
| Roof (rafters) | 0.20 | 0.13 | 40.00 |
| Ground floor   | 0.25 | 0.17 | 32.00 |
| Windows        | 2.00 | 1.40 | 15.00 |

- 2.4 The space heating requirement of the development will be reduced as a consequence of the fabric measures detailed above. In addition, the Applicant will specify boilers with a SEDBUK 2009 efficiency of at least 88.5%. The proposed dwellings will also benefit from enhanced heating controls to maximise efficiency in use. As well as having independent temperature controls such as thermostatic radiator valves, all dwellings will be supplied with programmers, timers and room thermostats.
- 2.5 Air tightness standards will be improved by the Applicant adopting predominantly Aircrete Product Association psi values for non-repeating thermal bridges, which better the thermal heat loss results delivered via traditional Accredited Construction Details. The Applicant's details incorporate thermal heat loss improvements by reducing air leakage loss and convective bypass of insulation. This approach will assist all dwellings in delivering a reduction in air permeability from  $10\text{m}^3/\text{hm}^2$  to not more than  $7\text{m}^3/\text{hm}^2$ .
- 2.6 Ventilation will be provided via high-efficiency, low energy extract fans. It is not proposed to provide any mechanical cooling to the proposed dwellings. Instead it is the intention of the Applicant to reduce the need for active cooling as far as possible. This will be achieved through the specification of mainly non-mechanical measures such as good thermal insulation and an air tight build. Openable windows will be installed as a necessary fixture in all dwellings to facilitate natural ventilation. These will help facilitate cross-ventilation, convective-ventilation and night purging.
- 2.7 All internal lighting throughout the New Barn Lane Park development will be of the dedicated low energy type. External lighting will also be low energy and some will be controlled through PIR sensors or daylight cut-off devices.

### **Feasibility of Renewable Energy and Low Carbon Technologies**

2.8 This section of the Statement conducts a thorough review of the renewable energy and low carbon technologies that could theoretically be applied to the New Barn Lane Park development. Renewable energy is defined as the flows of energy that occur naturally and repeatedly in the environment – from the wind, the fall of water, the movement of oceans, from the sun and also from biomass. This definition has been widened by the UK Government through the use of the term ‘Low or Zero Carbon Technologies’ (LZC), which include heat pumps and gas-fired CHP – technologies not always considered as being renewable. The technologies to be evaluated in this Statement are as follows:

- Combined Heat and Power (as per the requirements of Condition 14 / Policy ME4)
- Biomass
- Heat pumps (ground source and air source)
- Hydroelectric power
- Wind energy
- Solar thermal panels
- Solar photovoltaic panels

### **District Heating and Combined Heat and Power (CHP)**

2.9 CHP is a form of district heating that generally uses gas to generate electricity for local consumption, reducing the need for grid electricity and its associated high carbon dioxide emissions. As the CHP system is close to the point of energy demand, it is possible to use the heat that is generated during the electricity generation process. As both the electricity and heat from the generator is used, the efficiency of the system is increased above that of a conventional power plant where the heat is not utilised. CHP is suitable for dense, mixed-use developments where there is a very high, constant and varied heat demand.

2.10 The suitability of district heating and CHP to this development has been investigated in terms of appropriateness and how well the technology aligns itself with the Applicant’s priorities for this energy strategy, which are to provide the greatest reductions in carbon

dioxide emissions over the lifetime of the development and minimise pollutants using an affordable approach. While CHP would enable reductions in carbon dioxide emissions beyond the baseline case, the following reasons make it unsuited to this development:

- **Diversity and extent of heat demand** – CHP is best suited to developments where there is a diversity of energy demand. A mixed-use scheme, or a large residential scheme (>1,000 homes) will have extended periods of the day in which there is a continuous demand for heat. In these circumstances, the district heating network and CHP engine can operate consistently to generate electricity, with heat as a by-product. On a small-sized residential scheme such as this, heat demand will be intermittent, even during peak periods.
- **Thermal storage** – To compensate for fluctuations in the demand for heat, thermal buffers will be required to store CHP thermal output. To store heat without the need for dumping will require a large store that can take > 4 hours of charging. On a scheme of this size, such a thermal store could double the usual size of any plant room. Furthermore, to improve stratification, buffers should be at least 1.5 times as tall as they are wide, with a potential impact on height requirements.
- **Distributional heat losses** – thermal stores are a source of standing heat losses, as are even the best insulated distribution networks. When communal systems satisfy only a small and intermittent demand, these standing losses will represent a large part (>30%) of total demand. Carbon dioxide emissions savings gained within the dwellings through association with CHP may be considerably reduced by the additional heat losses associated with the network.
- **Plant room size and location** – to incorporate a central plant room would require a considerable amount of space. The most suitable location in terms of space would be the designated amenity space, but the installation of such infrastructure would be in conflict with the Applicant's objective to deliver a vibrant development with land uses suitable for children and young families.

- **Minimising heat demands** – the Applicant’s proposed energy strategy is based on the adoption of best practice standards for energy efficiency, an approach resulting in reduced space heating demands.
- **Installed costs** – the installed cost of any CHP / district heating network benefit from economies of scale. On a small-sized scheme such as New Barn Lane Park, any economies of scale would be negligible or non-existent.
- **Running costs** – the fixed costs associated with the management and operation of a communal plant room would need to be shared by future occupants as part of an energy standing charge. The smaller the scheme, the greater the cost for the individual occupant, a particularly unfair situation in the light of the Applicant’s commitment to provide 30% affordable housing. In addition, CHP engines impose additional running costs as contracts for maintenance and replacement costs are typically handled by specialist companies.
- **Absence of other local infrastructure** – there are no other CHP / district heating networks in the vicinity of the development with which to forge a connection to serve the New Barn Lane Park development.

## **Biomass**

2.11 Biomass community heating is an alternative to conventional fossil fuel heating but, as per the reasons used against the installation of gas-fuelled CHP, should be discounted as an option for the proposed dwellings. Biomass boilers within individual dwellings are usually installed with a standard gas boiler as back-up in case the occupier runs out of fuel. Although they are reducing in size, they are still large enough to require a dedicated room with additional space for the fuel – there is insufficient space available for such infrastructure in the vast majority of proposed dwelling types. The management of fuel deliveries and ash dispersal is also complex, which would necessitate a dedicated operative as opposed to residents of the future dwellings at New Barn Lane Park. Furthermore, the emissions of Nitrous Oxide and particulate matter that are associated with biomass installations would have the capacity to worsen local air pollution.

**Ground and Air Source Heat Pumps (GSHPs)**

- 2.12 Neither of these technologies has been considered for implementation at New Barn Lane Park due to their higher carbon dioxide emissions compared to the proposed gas boiler specification. Although both technologies are renowned for delivering reductions in carbon dioxide emissions, they do so from a much higher baseline than when gas is the specified fuel for space heating and hot water generation. Electricity consumption is also associated with much higher Nitrous Oxide emissions than Class 5 gas boilers.

**Hydroelectric power**

- 2.13 Hydroelectric power plants generate electricity using the gravitational force of flowing or falling water. However, there are no rivers of sufficient scale in the vicinity of the New Barn Lane Park development to facilitate a hydroelectric power installation.

**Wind Turbines**

- 2.14 Wind turbines are a modern, high-technology descendant of the windmills that have been around for centuries. In modern windmills the kinetic energy of the wind is used to turn a turbine to generate electricity as opposed to moving water or turning a grist mill wheel. A site with an average wind speed of 5m/s or more is generally considered to be suitable for installing a wind turbine. The average wind speed at the New Barn Lane Park development is 4.7m/s at 10m AOD and is below the level required to generate significant carbon dioxide reductions or commercial take-up. The installation of a single, large wind turbine to serve the development would also be controversial due to the nature of the locality. Even if space could be found within the development to accommodate a very high (15-20m) turbine, their installation would then present a significant visual blight to surrounding communities.

**Solar thermal and photovoltaic panels**

- 2.15 Solar thermal heating panels contribute to the hot water demand of a dwelling. Water or glycol (heat transfer liquid) is circulated to roof level where it is heated using solar energy before being returned to a thermal store where heat is exchanged with water from the conventional system. The proposed dwellings generally contain suitable attributes

(orientation, available roof-space and limited shadowing) for solar photovoltaic installations to be designed-in, although solar thermal installations are unsuitable. In part this is because the one and two bedroom flats/houses have very little space to accommodate a hot water cylinder. The specification of gas combination boilers also reduces the energy demand for heating and storing hot water.

- 2.16 There are few constraints on the capacity for solar photovoltaic panels to deliver reductions in emissions. For all dwellings on the site, roof-space is available at no worse than a west-east orientation, sufficient for solar photovoltaic installations to be effective at delivering emissions reductions. However, the current useful lifespan of solar photovoltaic panels is limited to a period of around twenty-five years on average. At this point the carbon dioxide emissions reductions will dissolve, and it is unlikely that the future owners of the dwellings will pay to replace their installation. Thus, the Applicant's preferred approach is to focus on delivering further energy efficient enhancements that result in emissions savings over the lifetime of the development, which can be assumed to be around 100 years.

### **3.0 Best Practice Energy Efficiency Measures**

#### **Introduction**

- 3.1 The Applicant's proposed approach is to better the carbon dioxide emissions standards set by Part L1a of Building Regulations (2013) through the installation of best practice energy efficiency measures. The Applicant will thus deliver a level of performance resulting in lower emissions for each dwelling type than the baseline standards set out in Table 1.

#### **Proposed Best Practice Energy Efficiency Measures**

- 3.2 In comparison to the performance standards necessary to comply with the Part L1a baseline scenario for carbon dioxide emissions, the Applicant proposes the following best practice design measures that will further enhance the energy efficiency of the new dwellings:

- Specification of 150mm of ground floor insulation (PIR) with very low thermal conductivity, reducing the average U-value from 0.17 to 0.11 W/m<sup>2</sup>K.
- Specification of enhanced double glazing, with this U-value reduced from 1.40 to 1.30 W/m<sup>2</sup>K.
- Adoption of Time and Temperature Zone Controls to all dwellings. As such, it will be possible for future occupants to minimise the energy demand and carbon dioxide emissions associated with the heating operation of their home in two defined localities.
- Commitment to reduce the air permeability of all dwellings from 7m<sup>3</sup>/hm<sup>2</sup> to not more than 5m<sup>3</sup>/hm<sup>2</sup>.

### Carbon Dioxide Emissions Analysis – After Best Practice Energy Efficiency Measures

3.3 As a result of the best practice energy efficiency measures detailed above, the Applicant's carbon dioxide emissions are reduced from the regulatory baseline scenario of **74,168 kgCO<sub>2</sub>/year** to **71,674 kgCO<sub>2</sub>/year**. The breakdown on a per house type basis is provided in Table 3 below. Examples of detailed SAP calculations for the most common dwelling types are provided in the Appendix to this Statement. The calculations pertaining to other dwelling types are available upon request.

**Table 3: Carbon Dioxide Emissions for the New Barn Lane Park Development Following Best Practice Energy Efficiency Measures**

| DWELLING TYPE            | REGULATED CARBON DIOXIDE EMISSIONS (kgCO <sub>2</sub> /yr) | NUMBER OF DWELLINGS | TOTAL EMISSIONS PER TYPE (kgCO <sub>2</sub> /yr) |
|--------------------------|------------------------------------------------------------|---------------------|--------------------------------------------------|
| <b>Private dwellings</b> |                                                            |                     |                                                  |
| Cooper                   | 1,200                                                      | 4                   | 4,800                                            |
| Chandler                 | 1,444                                                      | 10                  | 14,440                                           |
| Carver                   | 1,466                                                      | 3                   | 4,398                                            |
| Mason                    | 1,518                                                      | 4                   | 6,072                                            |

|                             |       |           |               |
|-----------------------------|-------|-----------|---------------|
| Scrivener                   | 1,654 | 5         | 8,270         |
| Milliner                    | 1,706 | 6         | 10,236        |
| Bowyer                      | 1,814 | 3         | 5,442         |
| <b>Private sub-total</b>    |       | <b>35</b> | <b>53,658</b> |
| <b>Affordable dwellings</b> |       |           |               |
| 1B Flat                     | 968   | 5         | 4,840         |
| 2B Flat                     | 1,150 | 1         | 1,150         |
| Baker                       | 1,273 | 5         | 6,375         |
| Ploughwright                | 1,399 | 3         | 4,197         |
| Cartographer                | 1,454 | 1         | 1,454         |
| <b>Affordable sub-total</b> |       | <b>15</b> | <b>18,016</b> |
| <b>TOTAL</b>                |       | <b>50</b> | <b>71,674</b> |

- 3.4 The introduction of enhanced energy efficiency measures has reduced carbon dioxide emissions from the baseline scenario by **2,494 kgCO<sub>2</sub>/year**, or **3.36%**. At first glance, this approach may appear inferior to an alternative strategy focused on renewable energy installations. The installation of an average of 17 kWp (apportioned to optimally orientated plots) of solar PV output would reduce carbon dioxide emissions by 7,417 kgCO<sub>2</sub>/year. This is equivalent to the 10% per annum reduction sought by Condition 10 and Policy ECC SP2 (Energy and Climate Change Mitigation) of Arun District Council's Local Plan (2014). However, adopting this approach ignores the likely lifetime emissions associated with the proposed development. It is reasonable to assume that the expected lifetime of the development will be approximately 100 years. As was stated in Section 2, the common lifespan of solar photovoltaic panels is around 25 years. After 25 years, there can be no guarantee that the panels will be replaced by the future homeowners. It is therefore important to compare the likely lifetime carbon dioxide emissions deriving from the Applicant's proposed strategy, focused on best practice energy efficiency measures, with the delivery of renewable energy proposals. Following the end of the working life of the solar photovoltaic panels, the carbon dioxide emissions in the alternative scenario will revert to those shown in Table 1, the baseline case.

3.5 Table 4 considers 3 possible scenarios and identifies the extrapolated lifetime carbon dioxide emissions at New Barn Lane Park over a period of 100 years:

- **Scenario A:** The Applicant complies with the regulatory baseline scenario without use of renewable energy installations;
- **Scenario B:** The proposed approach whereby the Applicant delivers a reduction in per annum carbon dioxide emissions of 10% (7,417 kgCO<sub>2</sub>) compared to the baseline case, purely through solar PV installations – these emissions savings last for 25 years then emissions revert to the theoretical baseline case;
- **Scenario C:** The Applicant's proposed approach involving the delivery of a reduction in carbon dioxide emissions of **2,494 kgCO<sub>2</sub>** per annum via best practice energy efficiency measures, lasting for the entirety of the 100 year lifespan of the dwellings.

**Table 4: Lifetime Carbon Dioxide Emissions at Stoke Park Farm**

| Scenario                                                   | Annual Carbon Dioxide Emissions (KgCO <sub>2</sub> /yr) | Predicted Lifetime Emissions (KgCO <sub>2</sub> ) |
|------------------------------------------------------------|---------------------------------------------------------|---------------------------------------------------|
| (A) Part L1a 2013 Building Regulations Compliance Standard | 74,168                                                  | 7,416,800                                         |
| (B) Renewable Energy Installations (17 kWp of solar PV)    | 71,674 (25 years) and 74,168 (75 years)                 | 7,354,450                                         |
| (C) Best Practice Energy Efficiency Measures               | 71,674                                                  | 7,167,400                                         |

3.6 It is evident from Table 4 that the Scenario C approach will result in lifetime carbon dioxide emissions of **187,050 kgCO<sub>2</sub>** less than the Scenario B strategy reliant on renewable energy installations. Thus, the Applicant's best practice energy efficiency proposals deliver lifetime carbon dioxide emissions some **2.54%** lower than a renewable energy strategy which delivers greater per annum reductions for a guaranteed period of only twenty-five years.

Furthermore, the Scenario C approach accords well with the requirements of current building regulations, which require all new dwellings to comply with a mandatory Fabric Energy Efficiency (FEE) standard. It is recognised by the Government, Building Research Establishment and Zero Carbon Hub that fabric energy efficiency benefits persist across the lifetime of any particular dwelling.

## **4.0 Conclusion**

- 4.1 This Energy Statement has set out the Applicant's proposed energy strategy for the New Barn Lane Park, Ferndown development. In response to the stipulations of Planning Condition 10, the Applicant's has proposed an approach that seeks to minimise energy consumption and carbon dioxide emissions at the point of demand through the installation of highly efficient fabric, ventilation and heating systems, together with the benefits of passive solar gains, all features which will help to lower the fuel bills of future occupants.
- 4.2 Over the course of the lifetime of the sixty proposed dwellings, such a strategy results in lower lifetime emissions (**by 2.54%**) than if the Applicant sought to comply with Condition 10's requirement for a 10% reduction in per annum emissions through the specification of renewable energy or low carbon technologies. The Applicant's proposed approach involving the integration of best practice energy efficiency measures will reduce the future energy bills of occupants.

## **Appendix**

SAP Calculation Examples (including best practice energy efficiency measures):

Type Chandler – Plot 8

Type Carver – Plot 11

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



|                                    |                                                   |               |          |                |            |
|------------------------------------|---------------------------------------------------|---------------|----------|----------------|------------|
| Property Reference                 | SECNEWB008                                        |               |          | Issued on Date | 15/09/2019 |
| Assessment Reference               | 001                                               | Prop Type Ref | Chandler |                |            |
| Property                           | Plot 8, New Barn Lane, Bersted, West Sussex, PO21 |               |          |                |            |
| SAP Rating                         | 85 B                                              | DER           | 15.35    | TER            | 15.89      |
| Environmental                      | 88 B                                              | % DER<TER     | 3.42     |                |            |
| CO <sub>2</sub> Emissions (t/year) | 1.05                                              | DFEE          | 40.43    | TFEE           | 40.60      |
| General Requirements Compliance    | Pass                                              | % DFEE<TFEE   | 0.41     |                |            |
| Assessor                           | Stephen Smith, [REDACTED]                         |               |          | Assessor ID    | D168-0001  |
| Client                             | Bellway Homes (Wessex)                            |               |          |                |            |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

#### DWELLING AS DESIGNED

End-Terrace House, total floor area 88 m<sup>2</sup>

This report covers items included within the SAP calculations.  
It is not a complete report of regulations compliance.

#### 1a TER and DER

Fuel for main heating:Mains gas  
Fuel factor:1.00 (mains gas)  
Target Carbon Dioxide Emission Rate (TER) 15.89 kgCO<sub>2</sub>/m<sup>2</sup>  
Dwelling Carbon Dioxide Emission Rate (DER) 15.35 kgCO<sub>2</sub>/m<sup>2</sup>OK

#### 1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)40.6 kWh/m<sup>2</sup>/yr  
Dwelling Fabric Energy Efficiency (DFEE)40.4 kWh/m<sup>2</sup>/yrOK

#### 2 Fabric U-values

| Element       | Average          | Highest          |    |
|---------------|------------------|------------------|----|
| External wall | 0.24 (max. 0.30) | 0.24 (max. 0.70) | OK |
| Party wall    | 0.00 (max. 0.20) | -                | OK |
| Floor         | 0.11 (max. 0.25) | 0.11 (max. 0.70) | OK |
| Roof          | 0.10 (max. 0.20) | 0.10 (max. 0.35) | OK |
| Openings      | 1.30 (max. 2.00) | 1.30 (max. 3.30) | OK |

#### 2a Thermal bridging

Thermal bridging calculated using user-specified y-value of 0.044

#### 3 Air permeability

Air permeability at 50 pascals: 5.00 (design value)  
Maximum 10.0 OK

#### 4 Heating efficiency

Main heating system: Boiler system with radiators or underfloor - Mains gas  
Data from database  
Ideal LOGIC COMBI ESP1 35  
Combi boiler  
Efficiency: 89.6% SEDBUK2009  
Minimum: 88.0% OK

#### Secondary heating system:

None

#### 5 Cylinder insulation

Hot water storage No cylinder

#### 6 Controls

Space heating controls: Time and temperature zone control OK

#### Hot water controls:

No cylinder

#### Boiler interlock

Yes OK

#### 7 Low energy lights

Percentage of fixed lights with low-energy fittings:100%  
Minimum 75% OK

#### 8 Mechanical ventilation

Continuous extract system (decentralised)  
Specific fan power: 0.1600 0.1600  
Maximum 0.7 OK

#### 9 Summertime temperature

Overheating risk (South East England): Slight OK  
Based on:  
Overshading: Average  
Windows facing North East: 4.88 m<sup>2</sup>, No overhang  
Windows facing South West: 7.10 m<sup>2</sup>, No overhang  
Air change rate: 4.00 ach  
Blinds/curtains: None

#### 10 Key features

Party wall U-value 0.00 W/m<sup>2</sup>K  
Roof U-value 0.10 W/m<sup>2</sup>K  
Floor U-value 0.11 W/m<sup>2</sup>K

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 44.1700 (1b)              | x 2.3500 (2b)                   | = 103.7995 (1b) - (3b)      |
| First floor                                            | 44.1700 (1c)              | x 2.5500 (2c)                   | = 112.6335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 88.3400                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 216.4330 (5)              |

#### 2. Ventilation rate

|                                                                           |        |        |        |        | main<br>heating | secondary<br>heating | other  |        | total  | m3 per hour |                             |              |             |
|---------------------------------------------------------------------------|--------|--------|--------|--------|-----------------|----------------------|--------|--------|--------|-------------|-----------------------------|--------------|-------------|
| Number of chimneys                                                        |        |        |        |        | 0               | +                    | 0      | +      | 0      | =           | 0 * 40 =                    | 0.0000 (6a)  |             |
| Number of open flues                                                      |        |        |        |        | 0               | +                    | 0      | +      | 0      | =           | 0 * 20 =                    | 0.0000 (6b)  |             |
| Number of intermittent 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)+(7a)+(7b)+(7c) = |        |        |        |        |                 |                      |        |        |        |             | Air changes per hour        |              |             |
| Pressure test                                                             |        |        |        |        |                 |                      |        |        |        |             | 0.0000 / (5) =              |              | 0.0000 (8)  |
| Measured/design AP50                                                      |        |        |        |        |                 |                      |        |        |        |             | Yes                         |              |             |
| Infiltration rate                                                         |        |        |        |        |                 |                      |        |        |        |             | 5.0000                      |              |             |
| Number of sides sheltered                                                 |        |        |        |        |                 |                      |        |        |        |             | 0.2500 (18)                 |              |             |
|                                                                           |        |        |        |        |                 |                      |        |        |        |             | 2 (19)                      |              |             |
| Shelter factor                                                            |        |        |        |        |                 |                      |        |        |        |             | (20) = 1 - [0.075 x (19)] = |              | 0.8500 (20) |
| Infiltration rate adjusted to include shelter factor                      |        |        |        |        |                 |                      |        |        |        |             | (21) = (18) x (20) =        |              | 0.2125 (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) |             |
|                                                                           | 0.2709 | 0.2656 | 0.2603 | 0.2338 | 0.2284          | 0.2019               | 0.2019 | 0.1966 | 0.2125 | 0.2284      | 0.2391                      | 0.2497 (22b) |             |
| Mechanical extract ventilation - decentralised                            |        |        |        |        |                 |                      |        |        |        |             |                             |              |             |
| If mechanical ventilation:                                                |        |        |        |        |                 |                      |        |        |        |             |                             | 0.5000 (23a) |             |
| Effective ac                                                              | 0.5209 | 0.5156 | 0.5103 | 0.5000 | 0.5000          | 0.5000               | 0.5000 | 0.5000 | 0.5000 | 0.5000      | 0.5000                      | 0.5000 (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  |                |                |                |                |                |      |
|---------------------------------------------------------------------|----------------|----------------|----------------|-----------------------|----------------|-------------------|----------------|----------------|----------------|----------------|----------------|----------------|------|
| Opening Type 1                                                      |                |                | 2.1200         | 1.3000                | 2.7560         |                   |                | (26)           |                |                |                |                |      |
| Opening Type 2 (Uw = 1.30)                                          |                |                | 11.9800        | 1.2357                | 14.8042        |                   |                | (27)           |                |                |                |                |      |
| Heat Loss Floor 1                                                   |                |                | 39.2500        | 0.1100                | 4.3175         |                   |                | (28a)          |                |                |                |                |      |
| External Wall 1                                                     | 88.9400        | 14.1000        | 74.8400        | 0.2400                | 17.9616        |                   |                | (29a)          |                |                |                |                |      |
| External Roof 1                                                     | 44.1700        |                | 44.1700        | 0.1000                | 4.4170         |                   |                | (30)           |                |                |                |                |      |
| Total net area of external elements Aum(A, m2)                      |                |                | 172.3600       |                       |                |                   |                | (31)           |                |                |                |                |      |
| Fabric heat loss, W/K = Sum (A x U)                                 |                |                |                | (26)... (30) + (32) = | 44.2563        |                   |                | (33)           |                |                |                |                |      |
| Party Wall 1                                                        |                |                | 38.6500        | 0.0000                | 0.0000         |                   |                | (32)           |                |                |                |                |      |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |                |                |                |                       |                |                   |                | 250.0000 (35)  |                |                |                |                |      |
| Thermal bridges (User defined value 0.044 * total exposed area)     |                |                |                |                       |                |                   |                | 7.5838 (36)    |                |                |                |                |      |
| Total fabric heat loss                                              |                |                |                |                       |                | (33) + (36) =     | 51.8401        | (37)           |                |                |                |                |      |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                |                       |                |                   |                |                |                |                |                |                |      |
| (38)m                                                               | Jan<br>37.2069 | Feb<br>36.8274 | Mar<br>36.4480 | Apr<br>35.7114        | May<br>35.7114 | Jun<br>35.7114    | Jul<br>35.7114 | Aug<br>35.7114 | Sep<br>35.7114 | Oct<br>35.7114 | Nov<br>35.7114 | Dec<br>35.7114 | (38) |
| Heat transfer coeff                                                 | 89.0470        | 88.6676        | 88.2881        | 87.5516               | 87.5516        | 87.5516           | 87.5516        | 87.5516        | 87.5516        | 87.5516        | 87.5516        | 87.5516        | (39) |
| Average = Sum(39)m / 12 =                                           |                |                |                |                       |                |                   |                |                |                |                |                | 87.8306        | (39) |
| HLP                                                                 | Jan<br>1.0080  | Feb<br>1.0037  | Mar<br>0.9994  | Apr<br>0.9911         | May<br>0.9911  | Jun<br>0.9911     | Jul<br>0.9911  | Aug<br>0.9911  | Sep<br>0.9911  | Oct<br>0.9911  | Nov<br>0.9911  | Dec<br>0.9911  | (40) |
| HLP (average)                                                       |                |                |                |                       |                |                   |                |                |                |                |                | 0.9942         | (40) |
| Days in month                                                       | 31             | 28             | 31             | 30                    | 31             | 30                | 31             | 31             | 30             | 31             | 30             | 31             | (41) |

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

|                                          |              |              |             |             |             |             |             |             |             |             |              |                                   |
|------------------------------------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------|-----------------------------------|
| Assumed occupancy                        |              |              |             |             |             |             |             |             |             |             |              | 2.6023 (42)                       |
| Average daily hot water use (litres/day) |              |              |             |             |             |             |             |             |             |             |              | 96.0049 (43)                      |
| Daily hot water use                      | Jan 105.6054 | Feb 101.7652 | Mar 97.9250 | Apr 94.0848 | May 90.2446 | Jun 86.4044 | Jul 86.4044 | Aug 90.2446 | Sep 94.0848 | Oct 97.9250 | Nov 101.7652 | Dec 105.6054 (44)                 |
| Energy conte                             | 156.6097     | 136.9718     | 141.3427    | 123.2260    | 118.2382    | 102.0306    | 94.5464     | 108.4933    | 109.7891    | 127.9486    | 139.6659     | 151.6681 (45)                     |
| Energy content (annual)                  |              |              |             |             |             |             |             |             |             |             |              | Total = Sum(45)m = 1510.5304 (45) |
| Distribution loss (46)m = 0.15 x (45)m   | 23.4915      | 20.5458      | 21.2014     | 18.4839     | 17.7357     | 15.3046     | 14.1820     | 16.2740     | 16.4684     | 19.1923     | 20.9499      | 22.7502 (46)                      |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Water storage loss:                                             |          |          |          |          |          |          |          |          |          |          |          |               |
| Total storage 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 (56)   |
| If cylinder contains dedicated solar storage                    |          |          |          |          |          |          |          |          |          |          |          |               |
|                                                                 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (57)   |
| Combi loss                                                      | 14.1324  | 12.7540  | 14.0887  | 13.5910  | 14.0126  | 13.5244  | 13.9526  | 13.9915  | 13.5607  | 14.0573  | 13.6480  | 14.1206 (61)  |
| Total heat required for water heating calculated for each month |          |          |          |          |          |          |          |          |          |          |          |               |
|                                                                 | 170.7421 | 149.7258 | 155.4314 | 136.8170 | 132.2509 | 115.5550 | 108.4990 | 122.4849 | 123.3498 | 142.0059 | 153.3139 | 165.7887 (62) |
| 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 (63)   |
| Solar input (sum of months) = Sum(63)m = 0.0000 (63)            |          |          |          |          |          |          |          |          |          |          |          |               |
| Output from w/h                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|                                                                 | 170.7421 | 149.7258 | 155.4314 | 136.8170 | 132.2509 | 115.5550 | 108.4990 | 122.4849 | 123.3498 | 142.0059 | 153.3139 | 165.7887 (64) |
| Total per year (kWh/year) = Sum(64)m = 1675.9644 (64)           |          |          |          |          |          |          |          |          |          |          |          |               |
| Heat gains from water heating, kWh/month                        |          |          |          |          |          |          |          |          |          |          |          |               |
|                                                                 | 55.6058  | 48.7316  | 50.5186  | 44.3704  | 42.8174  | 37.3063  | 34.9248  | 39.5719  | 39.8950  | 46.0572  | 49.8509  | 53.9598 (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                                                                               | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 22.7284   | 20.1872   | 16.4173   | 12.4290   | 9.2908    | 7.8437    | 8.4754    | 11.0166   | 14.7865   | 18.7748   | 21.9130   | 23.3601   | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 235.9904  | 238.4392  | 232.2682  | 219.1309  | 202.5474  | 186.9612  | 176.5487  | 174.0998  | 180.2708  | 193.4082  | 209.9917  | 225.5779  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | (69) |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | (71) |
| Water heating gains (Table 5)                                                       | 74.7390   | 72.5173   | 67.9014   | 61.6255   | 57.5502   | 51.8143   | 46.9420   | 53.1881   | 55.4098   | 61.9049   | 69.2374   | 72.5266   | (72) |
| Total internal gains                                                                | 398.4925  | 396.1784  | 381.6216  | 358.2201  | 334.4231  | 311.6538  | 297.0007  | 303.3392  | 315.5018  | 339.1225  | 366.1767  | 386.4992  | (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   |
|-------------|----------|----------|----------|------------|--------------------------------|-----------------------------------|------------------------------------|----------|----------|------------------------------|----------|----------|--------------|
| Northeast   |          |          |          | 4.8800     | 11.2829                        | 0.7200                            | 0.7000                             |          |          | 0.7700                       |          |          | 19.2312 (75) |
| Southwest   |          |          |          | 7.1000     | 36.7938                        | 0.7200                            | 0.7000                             |          |          | 0.7700                       |          |          | 91.2425 (79) |
|             |          |          |          |            |                                |                                   |                                    |          |          |                              |          |          |              |
| Solar gains | 110.4737 | 194.5653 | 283.1800 | 379.3134   | 450.8209                       | 458.9791                          | 437.7530                           | 382.6595 | 316.1966 | 219.6110                     | 133.4853 | 93.7897  | (83)         |
| Total gains | 508.9662 | 590.7437 | 664.8016 | 737.5334   | 785.2440                       | 770.6329                          | 734.7537                           | 685.9987 | 631.6984 | 558.7335                     | 499.6620 | 480.2889 | (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                                                                         | 68.8931 | 69.1879 | 69.4853 | 70.0698 | 70.0698 | 70.0698 | 70.0698 | 70.0698 | 70.0698 | 70.0698 | 70.0698 | 70.0698 |              |
| alpha                                                                       | 5.5929  | 5.6125  | 5.6324  | 5.6713  | 5.6713  | 5.6713  | 5.6713  | 5.6713  | 5.6713  | 5.6713  | 5.6713  | 5.6713  |              |
| util living area                                                            | 0.9984  | 0.9958  | 0.9878  | 0.9572  | 0.8651  | 0.6901  | 0.5178  | 0.5749  | 0.8305  | 0.9748  | 0.9962  | 0.9988  | (86)         |
| MIT                                                                         | 19.9316 | 20.0833 | 20.3185 | 20.6131 | 20.8523 | 20.9688 | 20.9948 | 20.9909 | 20.9130 | 20.5994 | 20.2126 | 19.9149 | (87)         |
| Th 2                                                                        | 20.0767 | 20.0802 | 20.0838 | 20.0908 | 20.0908 | 20.0908 | 20.0908 | 20.0908 | 20.0908 | 20.0908 | 20.0908 | 20.0908 | (88)         |
| util rest of house                                                          | 0.9978  | 0.9945  | 0.9836  | 0.9419  | 0.8204  | 0.6069  | 0.4143  | 0.4675  | 0.7613  | 0.9629  | 0.9947  | 0.9984  | (89)         |
| MIT 2                                                                       | 18.6429 | 18.8668 | 19.2107 | 19.6336 | 19.9458 | 20.0699 | 20.0888 | 20.0869 | 20.0208 | 19.6210 | 19.0640 | 18.6288 | (90)         |
| Living area fraction                                                        | 18.9516 | 19.1582 | 19.4760 | 19.8682 | 20.1629 | 20.2852 | 20.3058 | 20.3034 | 20.2345 | 19.8554 | 19.3391 | 18.9369 | (92)         |
| MIT                                                                         | 18.9516 | 19.1582 | 19.4760 | 19.8682 | 20.1629 | 20.2852 | 20.3058 | 20.3034 | 20.2345 | 19.8554 | 19.3391 | 18.9369 | (92)         |
| Temperature adjustment                                                      | 18.8016 | 19.0082 | 19.3260 | 19.7182 | 20.0129 | 20.1352 | 20.1558 | 20.1534 | 20.0845 | 19.7054 | 19.1891 | 18.7869 | (93)         |
| adjusted MIT                                                                | 18.8016 | 19.0082 | 19.3260 | 19.7182 | 20.0129 | 20.1352 | 20.1558 | 20.1534 | 20.0845 | 19.7054 | 19.1891 | 18.7869 | (93)         |

#### 8. Space heating requirement

|                      | Jan       | Feb       | Mar       | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec          |              |
|----------------------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|-----------|--------------|--------------|
| Utilisation          | 0.9967    | 0.9921    | 0.9788    | 0.9340   | 0.8160   | 0.6112   | 0.4218   | 0.4752   | 0.7607   | 0.9560   | 0.9925    | 0.9976       | (94)         |
| Useful gains         | 507.2736  | 586.0866  | 650.7194  | 688.8518 | 640.7656 | 471.0480 | 309.9351 | 325.9648 | 480.5434 | 534.1744 | 495.9001  | 479.1180     | (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     | 1291.3197 | 1250.9404 | 1132.3850 | 947.1524 | 727.8079 | 484.6186 | 311.3162 | 328.6193 | 523.9550 | 797.1914 | 1058.4198 | 1277.1026    | (97)         |
| Month fracti         | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000   | 1.0000    | 1.0000       | (97a)        |
| Space heating kWh    | 583.3303  | 446.7817  | 358.3592  | 185.9765 | 64.7595  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 195.6847 | 405.0142  | 593.7005     | (98)         |
| Space heating        |           |           |           |          |          |          |          |          |          |          |           | 2833.6066    | (98)         |
| Space heating per m2 |           |           |           |          |          |          |          |          |          |          |           | (98) / (4) = | 32.0761 (99) |

#### 8c. Space cooling requirement

Not applicable

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

### 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 %)                                         |          |          |          |          |          |          |          |          |          |          |          |          | 90.5000 (206)   |
| Efficiency of secondary/supplementary heating system, %                                  |          |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (208)    |
| Space heating requirement                                                                |          |          |          |          |          |          |          |          |          |          |          |          | 3131.0570 (211) |
|                                                                                          | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec      |                 |
| Space heating requirement                                                                | 583.3303 | 446.7817 | 358.3592 | 185.9765 | 64.7595  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 195.6847 | 405.0142 | 593.7005 | (98)            |
| Space heating efficiency (main heating system 1)                                         | 90.5000  | 90.5000  | 90.5000  | 90.5000  | 90.5000  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 90.5000  | 90.5000  | 90.5000  | (210)           |
| Space heating fuel (main heating system)                                                 | 644.5639 | 493.6815 | 395.9770 | 205.4988 | 71.5574  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 216.2262 | 447.5295 | 656.0227 | (211)           |
| Water heating requirement                                                                | 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                                                                | 170.7421 | 149.7258 | 155.4314 | 136.8170 | 132.2509 | 115.5550 | 108.4990 | 122.4849 | 123.3498 | 142.0059 | 153.3139 | 165.7887 | (64)            |
| Efficiency of water heater (217)m                                                        | 89.7551  | 89.6749  | 89.5075  | 89.1155  | 88.3266  | 87.3000  | 87.3000  | 87.3000  | 87.3000  | 89.1262  | 89.5982  | 89.7816  | (217)           |
| Fuel for water heating, kWh/month                                                        | 190.2312 | 166.9651 | 173.6519 | 153.5278 | 149.7294 | 132.3654 | 124.2829 | 140.3034 | 141.2942 | 159.3312 | 171.1128 | 184.6577 | (219)           |
| Water heating fuel used                                                                  |          |          |          |          |          |          |          |          |          |          |          |          | 1887.4530 (219) |
| Annual totals kWh/year                                                                   |          |          |          |          |          |          |          |          |          |          |          |          |                 |
| Space heating fuel - main system                                                         |          |          |          |          |          |          |          |          |          |          |          |          | 3131.0570 (211) |
| Space heating fuel - secondary                                                           |          |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (215)    |
| Electricity for pumps and fans:                                                          |          |          |          |          |          |          |          |          |          |          |          |          |                 |
| (MEV)Decentralised, Database: total watage = 5.3360, total flow = 29.0000, SFP = 0.1840) |          |          |          |          |          |          |          |          |          |          |          |          |                 |
| mechanical ventilation fans (SFP = 0.1840)                                               |          |          |          |          |          |          |          |          |          |          |          |          | 48.5849 (230a)  |
| central heating pump                                                                     |          |          |          |          |          |          |          |          |          |          |          |          | 30.0000 (230c)  |
| main heating flue fan                                                                    |          |          |          |          |          |          |          |          |          |          |          |          | 45.0000 (230e)  |
| Total electricity for the above, kWh/year                                                |          |          |          |          |          |          |          |          |          |          |          |          | 123.5849 (231)  |
| Electricity for lighting (calculated in Appendix L)                                      |          |          |          |          |          |          |          |          |          |          |          |          | 401.3909 (232)  |
| Total delivered energy for all uses                                                      |          |          |          |          |          |          |          |          |          |          |          |          | 5543.4857 (238) |

### 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               | 3131.0570          | 0.2160                        | 676.3083 (261)           |
| Space heating - secondary                   | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)                  | 1887.4530          | 0.2160                        | 407.6898 (264)           |
| Space and water heating                     |                    |                               | 1083.9981 (265)          |
| Pumps and fans                              | 123.5849           | 0.5190                        | 64.1406 (267)            |
| Energy for lighting                         | 401.3909           | 0.5190                        | 208.3219 (268)           |
| Total CO2, kg/year                          |                    |                               | 1356.4606 (272)          |
| Dwelling Carbon Dioxide Emission Rate (DER) |                    |                               | 15.3500 (273)            |

### 16 CO2 EMISSIONS ASSOCIATED WITH APPLIANCES AND COOKING AND SITE-WIDE ELECTRICITY GENERATION TECHNOLOGIES

|                                                                                 |  |     |             |
|---------------------------------------------------------------------------------|--|-----|-------------|
| DER                                                                             |  |     | 15.3500 ZC1 |
| Total Floor Area                                                                |  | TFA | 88.3400     |
| Assumed number of occupants                                                     |  | N   | 2.6023      |
| CO2 emission factor in Table 12 for electricity displaced from grid             |  | EF  | 0.5190      |
| CO2 emissions from appliances, equation (L14)                                   |  |     | 15.8301 ZC2 |
| CO2 emissions from cooking, equation (L16)                                      |  |     | 2.0541 ZC3  |
| Total CO2 emissions                                                             |  |     | 33.2341 ZC4 |
| Residual CO2 emissions offset from biofuel CHP                                  |  |     | 0.0000 ZC5  |
| Additional allowable electricity generation, kWh/m²/year                        |  |     | 0.0000 ZC6  |
| Resulting CO2 emissions offset from additional allowable electricity generation |  |     | 0.0000 ZC7  |
| Net CO2 emissions                                                               |  |     | 33.2341 ZC8 |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF TARGET EMISSIONS 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)            | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------|-----------------------------|
| Ground floor                                           | 44.1700 (1b)              | x 2.3500 (2b)                   | = 103.7995 (1b) - (3b)      |
| First floor                                            | 44.1700 (1c)              | x 2.5500 (2c)                   | = 112.6335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 88.3400                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 216.4330 (5)              |

#### 2. Ventilation rate

|                                                      | main<br>heating              | +      | secondary<br>heating | +      | other  | =      | total                       | m3 per hour  |        |        |        |              |
|------------------------------------------------------|------------------------------|--------|----------------------|--------|--------|--------|-----------------------------|--------------|--------|--------|--------|--------------|
| Number of chimneys                                   | 0                            | +      | 0                    | +      | 0      | =      | 0 * 40 =                    | 0.0000 (6a)  |        |        |        |              |
| Number of open flues                                 | 0                            | +      | 0                    | +      | 0      | =      | 0 * 20 =                    | 0.0000 (6b)  |        |        |        |              |
| Number of intermittent fans                          |                              |        |                      |        |        |        | 3 * 10 =                    | 30.0000 (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)+(7a)+(7b)+(7c) = |        |                      |        |        |        | 30.0000 / (5) =             | 0.1386 (8)   |        |        |        |              |
| Pressure test                                        |                              |        |                      |        |        |        | Yes                         |              |        |        |        |              |
| Measured/design AP50                                 |                              |        |                      |        |        |        | 5.0000                      |              |        |        |        |              |
| Infiltration rate                                    |                              |        |                      |        |        |        | 0.3886                      | (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) =        | 0.3303 (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) |
|                                                      | 0.4212                       | 0.4129 | 0.4046               | 0.3634 | 0.3551 | 0.3138 | 0.3138                      | 0.3055       | 0.3303 | 0.3551 | 0.3716 | 0.3881 (22b) |
| Effective ac                                         | 0.5887                       | 0.5852 | 0.5819               | 0.5660 | 0.5630 | 0.5492 | 0.5492                      | 0.5467       | 0.5546 | 0.5630 | 0.5690 | 0.5753 (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                                                     |                |                | 2.1200         | 1.0000                | 2.1200         |                   | (26)           |                |                |                |                |                     |
| TER Opening Type (Uw = 1.40)                                        |                |                | 11.9800        | 1.3258                | 15.8826        |                   | (27)           |                |                |                |                |                     |
| Heat Loss Floor 1                                                   |                |                | 39.2500        | 0.1300                | 5.1025         |                   | (28a)          |                |                |                |                |                     |
| External Wall 1                                                     | 88.9400        | 14.1000        | 74.8400        | 0.1800                | 13.4712        |                   | (29a)          |                |                |                |                |                     |
| External Roof 1                                                     | 44.1700        |                | 44.1700        | 0.1300                | 5.7421         |                   | (30)           |                |                |                |                |                     |
| Total net area of external elements Aum(A, m2)                      |                |                | 172.3600       |                       |                |                   | (31)           |                |                |                |                |                     |
| Fabric heat loss, W/K = Sum (A x U)                                 |                |                |                | (26)... (30) + (32) = | 42.3184        |                   | (33)           |                |                |                |                |                     |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |                |                |                |                       |                |                   | 250.0000 (35)  |                |                |                |                |                     |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |                |                |                |                       |                |                   | 0.0000 (36)    |                |                |                |                |                     |
| Total fabric heat loss                                              |                |                |                |                       |                | (33) + (36) =     | 42.3184 (37)   |                |                |                |                |                     |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                |                       |                |                   |                |                |                |                |                |                     |
| (38)m                                                               | Jan<br>42.0457 | Feb<br>41.7997 | Mar<br>41.5586 | Apr<br>40.4262        | May<br>40.2143 | Jun<br>39.2280    | Jul<br>39.2280 | Aug<br>39.0454 | Sep<br>39.6080 | Oct<br>40.2143 | Nov<br>40.6430 | Dec<br>41.0911 (38) |
| Heat transfer coeff                                                 | 84.3641        | 84.1181        | 83.8770        | 82.7446               | 82.5327        | 81.5464           | 81.5464        | 81.3638        | 81.9263        | 82.5327        | 82.9613        | 83.4094 (39)        |
| Average = Sum(39)m / 12 =                                           |                |                |                |                       |                |                   |                |                |                |                |                | 82.7436 (39)        |
| HLP                                                                 | Jan<br>0.9550  | Feb<br>0.9522  | Mar<br>0.9495  | Apr<br>0.9367         | May<br>0.9343  | Jun<br>0.9231     | Jul<br>0.9231  | Aug<br>0.9210  | Sep<br>0.9274  | Oct<br>0.9343  | Nov<br>0.9391  | Dec<br>0.9442 (40)  |
| HLP (average)                                                       |                |                |                |                       |                |                   |                |                |                |                |                | 0.9366 (40)         |
| Days in month                                                       | 31             | 28             | 31             | 30                    | 31             | 30                | 31             | 31             | 30             | 31             | 30             | 31 (41)             |

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

|                                              |              |              |             |             |             |             |             |             |             |                    |              |                   |
|----------------------------------------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------------|--------------|-------------------|
| Assumed occupancy                            |              |              |             |             |             |             |             |             |             |                    |              | 2.6023 (42)       |
| Average daily hot water use (litres/day)     |              |              |             |             |             |             |             |             |             |                    |              | 96.0049 (43)      |
| Daily hot water use                          | Jan 105.6054 | Feb 101.7652 | Mar 97.9250 | Apr 94.0848 | May 90.2446 | Jun 86.4044 | Jul 86.4044 | Aug 90.2446 | Sep 94.0848 | Oct 97.9250        | Nov 101.7652 | Dec 105.6054 (44) |
| Energy conte                                 | 156.6097     | 136.9718     | 141.3427    | 123.2260    | 118.2382    | 102.0306    | 94.5464     | 108.4933    | 109.7891    | 127.9486           | 139.6659     | 151.6681 (45)     |
| Energy content (annual)                      |              |              |             |             |             |             |             |             |             | Total = Sum(45)m = |              | 1510.5304 (45)    |
| Distribution loss (46)m = 0.15 x (45)m       |              |              |             |             |             |             |             |             |             |                    |              |                   |
| 23.4915                                      | 20.5458      | 21.2014      | 18.4839     | 17.7357     | 15.3046     | 14.1820     | 16.2740     | 16.4684     | 19.1923     | 20.9499            | 22.7502 (46) |                   |
| Water storage loss:                          |              |              |             |             |             |             |             |             |             |                    |              |                   |
| Total storage 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 (56)       |
| If cylinder contains dedicated solar storage |              |              |             |             |             |             |             |             |             |                    |              |                   |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |          |          |          |      |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|------|
| 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   | 0.0000   | 0.0000   | (57) |
| Total heat required for water heating calculated for each month | 50.9589  | 46.0274  | 49.9015  | 46.3980  | 45.9876  | 42.6104  | 44.0307  | 45.9876  | 46.3980  | 49.9015  | 49.3151  | 50.9589  | 50.9589  | 50.9589  | (61) |
| Solar input                                                     | 207.5686 | 182.9992 | 191.2442 | 169.6239 | 164.2259 | 144.6410 | 138.5771 | 154.4810 | 156.1871 | 177.8501 | 188.9810 | 202.6270 | 202.6270 | 202.6270 | (62) |
| Output from w/h                                                 | 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   | 0.0000   | (63) |
| Heat gains from water heating, kWh/month                        | 207.5686 | 182.9992 | 191.2442 | 169.6239 | 164.2259 | 144.6410 | 138.5771 | 154.4810 | 156.1871 | 177.8501 | 188.9810 | 202.6270 | 202.6270 | 202.6270 | (64) |
|                                                                 | 64.8124  | 57.0500  | 59.4718  | 52.5721  | 50.8111  | 44.5778  | 42.4443  | 47.5709  | 48.1044  | 55.0183  | 58.7677  | 63.1694  | 63.1694  | 63.1694  | (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                                                                               | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | 130.1155  | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 22.7284   | 20.1872   | 16.4173   | 12.4290   | 9.2908    | 7.8437    | 8.4754    | 11.0166   | 14.7865   | 18.7748   | 21.9130   | 23.3601   | 23.3601   | 23.3601   | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 235.9904  | 238.4392  | 232.2682  | 219.1309  | 202.5474  | 186.9612  | 176.5487  | 174.0998  | 180.2708  | 193.4082  | 209.9917  | 225.5779  | 225.5779  | 225.5779  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | 36.0116   | (69) |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | -104.0924 | (71) |
| Water heating gains (Table 5)                                                       | 87.1135   | 84.8958   | 79.9352   | 73.0168   | 68.2945   | 61.9136   | 57.0489   | 63.9394   | 66.8116   | 73.9493   | 81.6218   | 84.9051   | 84.9051   | 84.9051   | (72) |
| Total internal gains                                                                | 410.8670  | 408.5569  | 393.6554  | 369.6114  | 345.1674  | 321.7531  | 307.1076  | 314.0905  | 326.9036  | 351.1670  | 378.5611  | 398.8777  | 398.8777  | 398.8777  | (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 | Access<br>factor<br>Table 6d | Gains<br>W |          |          |          |          |          |          |          |          |      |
| Northeast   | 4.8800     | 11.2829                        | 0.6300                       | 0.7000                       | 0.7700                       | 16.8273    | (75)     |          |          |          |          |          |          |          |      |
| Southwest   | 7.1000     | 36.7938                        | 0.6300                       | 0.7000                       | 0.7700                       | 79.8372    | (79)     |          |          |          |          |          |          |          |      |
| Solar gains | 96.6645    | 170.2447                       | 247.7825                     | 331.8992                     | 394.4683                     | 401.6067   | 383.0339 | 334.8271 | 276.6720 | 192.1596 | 116.7996 | 82.0660  | 82.0660  | 82.0660  | (83) |
| Total gains | 507.5314   | 578.8016                       | 641.4379                     | 701.5106                     | 739.6357                     | 723.3598   | 690.1415 | 648.9177 | 603.5756 | 543.3265 | 495.3607 | 480.9437 | 480.9437 | 480.9437 | (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                                                                         | 72.7172 | 72.9299 | 73.1395 | 74.1405 | 74.3308 | 75.2298 | 75.2298 | 75.3987 | 74.8810                   | 74.3308 | 73.9468 | 73.5495 | 73.5495 | 73.5495 | 73.5495 |      |
| alpha                                                                       | 5.8478  | 5.8620  | 5.8760  | 5.9427  | 5.9554  | 6.0153  | 6.0153  | 6.0266  | 5.9921                    | 5.9554  | 5.9298  | 5.9033  | 5.9033  | 5.9033  | 5.9033  |      |
| util living area                                                            | 0.9984  | 0.9961  | 0.9889  | 0.9605  | 0.8716  | 0.6901  | 0.5150  | 0.5677  | 0.8274                    | 0.9749  | 0.9962  | 0.9988  | 0.9988  | 0.9988  | 0.9988  | (86) |
| MIT                                                                         | 20.0056 | 20.1422 | 20.3579 | 20.6379 | 20.8640 | 20.9748 | 20.9962 | 20.9935 | 20.9270                   | 20.6363 | 20.2707 | 19.9828 | 19.9828 | 19.9828 | 19.9828 | (87) |
| Th 2                                                                        | 20.1210 | 20.1233 | 20.1256 | 20.1365 | 20.1385 | 20.1479 | 20.1479 | 20.1497 | 20.1443                   | 20.1385 | 20.1344 | 20.1301 | 20.1301 | 20.1301 | 20.1301 | (88) |
| util rest of house                                                          | 0.9978  | 0.9948  | 0.9850  | 0.9464  | 0.8292  | 0.6110  | 0.4179  | 0.4675  | 0.7604                    | 0.9632  | 0.9947  | 0.9984  | 0.9984  | 0.9984  | 0.9984  | (89) |
| MIT 2                                                                       | 18.7838 | 18.9849 | 19.2997 | 19.7058 | 20.0038 | 20.1309 | 20.1464 | 20.1469 | 20.0855                   | 19.7107 | 19.1812 | 18.7574 | 18.7574 | 18.7574 | 18.7574 | (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.2395  | 0.2395  | 0.2395  | 0.2395  | (91) |
| MIT                                                                         | 19.0764 | 19.2621 | 19.5532 | 19.9290 | 20.2098 | 20.3331 | 20.3500 | 20.3497 | 20.2870                   | 19.9324 | 19.4422 | 19.0509 | 19.0509 | 19.0509 | 19.0509 | (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | 0.0000  | 0.0000  | 0.0000  | 0.0000  |      |
| adjusted MIT                                                                | 19.0764 | 19.2621 | 19.5532 | 19.9290 | 20.2098 | 20.3331 | 20.3500 | 20.3497 | 20.2870                   | 19.9324 | 19.4422 | 19.0509 | 19.0509 | 19.0509 | 19.0509 | (93) |

#### 8. Space heating requirement

|                      |           |           |           |          |          |          |          |          |          |          |           |           |           |           |           |       |
|----------------------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|-------|
| Utilisation          | Jan       | Feb       | Mar       | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec       |           |           |           |       |
| Useful gains         | 505.9569  | 574.7398  | 629.6616  | 661.0024 | 616.2352 | 454.9519 | 304.5215 | 318.9936 | 466.4202 | 521.3568 | 491.8881  | 479.8376  | 479.8376  | 479.8376  | 479.8376  | (94)  |
| 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    | 4.2000    | 4.2000    | 4.2000    | (96)  |
| Heat loss rate W     | 1246.5997 | 1208.1148 | 1094.8602 | 912.5917 | 702.3385 | 467.5109 | 305.7986 | 321.3590 | 506.8812 | 770.2295 | 1023.9237 | 1238.7068 | 1238.7068 | 1238.7068 | 1238.7068 | (97)  |
| Month fracti         | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 1.0000   | 1.0000   | 1.0000   | 1.0000   | 1.0000   | 1.0000   | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000    | (97a) |
| Space heating kWh    | 551.0382  | 425.6280  | 346.1078  | 181.1443 | 64.0608  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 185.1612 | 383.0656  | 564.5986  | 564.5986  | 564.5986  | 564.5986  | (98)  |
| Space heating        |           |           |           |          |          |          |          |          |          |          |           | 2700.8047 | 2700.8047 | 2700.8047 | 2700.8047 | (98)  |
| Space heating per m2 |           |           |           |          |          |          |          |          |          |          |           | 30.5728   | 30.5728   | 30.5728   | 30.5728   | (99)  |

#### 8c. Space cooling requirement

Not applicable

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

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

|                                                                       |          |          |          |          |          |          |          |          |          |          |          |           |                 |
|-----------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------------|
| 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 %)                      |          |          |          |          |          |          |          |          |          |          |          |           | 93.4000 (206)   |
| Efficiency of secondary/supplementary heating system, %               |          |          |          |          |          |          |          |          |          |          |          |           | 0.0000 (208)    |
| Space heating requirement                                             |          |          |          |          |          |          |          |          |          |          |          |           | 2891.6539 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec       |                 |
| Space heating requirement                                             | 551.0382 | 425.6280 | 346.1078 | 181.1443 | 64.0608  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 185.1612 | 383.0656 | 564.5986  | (98)            |
| Space heating efficiency (main heating system 1)                      | 93.4000  | 93.4000  | 93.4000  | 93.4000  | 93.4000  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 93.4000  | 93.4000  | 93.4000   | (210)           |
| Space heating fuel (main heating system)                              | 589.9767 | 455.7045 | 370.5651 | 193.9447 | 68.5876  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 198.2454 | 410.1345 | 604.4953  | (211)           |
| Water heating requirement                                             | 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                                             | 207.5686 | 182.9992 | 191.2442 | 169.6239 | 164.2259 | 144.6410 | 138.5771 | 154.4810 | 156.1871 | 177.8501 | 188.9810 | 202.6270  | (64)            |
| Efficiency of water heater                                            | 87.3924  | 87.1058  | 86.5267  | 85.2168  | 82.8990  | 80.3000  | 80.3000  | 80.3000  | 80.3000  | 85.1527  | 86.7935  | 87.4936   | (217)           |
| Fuel for water heating, kWh/month                                     | 237.5134 | 210.0885 | 221.0234 | 199.0499 | 198.1035 | 180.1258 | 172.5742 | 192.3798 | 194.5044 | 208.8602 | 217.7362 | 231.5907  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |          |          | 2463.5499 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |          |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |          |          | 2891.6539 | (211)           |
| Space heating fuel - secondary                                        |          |          |          |          |          |          |          |          |          |          |          | 0.0000    | (215)           |
| Electricity for pumps and fans:                                       |          |          |          |          |          |          |          |          |          |          |          |           |                 |
| central heating pump                                                  |          |          |          |          |          |          |          |          |          |          |          | 30.0000   | (230c)          |
| main heating flue fan                                                 |          |          |          |          |          |          |          |          |          |          |          | 45.0000   | (230e)          |
| Total electricity for the above, kWh/year                             |          |          |          |          |          |          |          |          |          |          |          | 75.0000   | (231)           |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |          |          |          |          |          |          |          | 401.3909  | (232)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |          |          | 5831.5947 | (238)           |

### 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                                                                     | 2891.6539          | 0.2160                        | 624.5972 (261)           |
| Space heating - secondary                                                                         | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)                                                                        | 2463.5499          | 0.2160                        | 532.1268 (264)           |
| Space and water heating                                                                           |                    |                               | 1156.7240 (265)          |
| Pumps and fans                                                                                    | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                                                                               | 401.3909           | 0.5190                        | 208.3219 (268)           |
| Total CO2, kg/m2/year                                                                             |                    |                               | 1403.9709 (272)          |
| Emissions per m2 for space and water heating                                                      |                    |                               | 13.0940 (272a)           |
| Fuel factor (mains gas)                                                                           |                    |                               | 1.0000                   |
| Emissions per m2 for lighting                                                                     |                    |                               | 2.3582 (272b)            |
| Emissions per m2 for pumps and fans                                                               |                    |                               | 0.4406 (272c)            |
| Target Carbon Dioxide Emission Rate (TER) = (13.0940 * 1.00) + 2.3582 + 0.4406, rounded to 2 d.p. |                    |                               | 15.8900 (273)            |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



|                                    |                                                |               |        |                |            |
|------------------------------------|------------------------------------------------|---------------|--------|----------------|------------|
| Property Reference                 | SECNEWB011                                     |               |        | Issued on Date | 15/09/2019 |
| Assessment Reference               | 001                                            | Prop Type Ref | Carver |                |            |
| Property                           | Plot 11, Holmwood Park, Ferndown, Dorset, BH22 |               |        |                |            |
| SAP Rating                         | 85 B                                           | DER           | 16.30  | TER            | 16.81      |
| Environmental                      | 87 B                                           | % DER<TER     | 3.04   |                |            |
| CO <sub>2</sub> Emissions (t/year) | 1.20                                           | DFEE          | 46.52  | TFEE           | 47.93      |
| General Requirements Compliance    | Pass                                           | % DFEE<TFEE   | 2.93   |                |            |
| Assessor                           | Stephen Smith, [REDACTED]                      |               |        | Assessor ID    | D168-0001  |
| Client                             | Bellway Homes (Wessex)                         |               |        |                |            |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

REGULATIONS COMPLIANCE REPORT - Approved Document L1A, 2013 Edition, England

#### DWELLING AS DESIGNED

Detached House, total floor area 92 m<sup>2</sup>

This report covers items included within the SAP calculations.  
It is not a complete report of regulations compliance.

#### 1a TER and DER

Fuel for main heating:Mains gas  
Fuel factor:1.00 (mains gas)  
Target Carbon Dioxide Emission Rate (TER) 16.81 kgCO<sub>2</sub>/m<sup>2</sup>  
Dwelling Carbon Dioxide Emission Rate (DER) 16.30 kgCO<sub>2</sub>/m<sup>2</sup>OK

#### 1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE)47.9 kWh/m<sup>2</sup>/yr  
Dwelling Fabric Energy Efficiency (DFEE)46.5 kWh/m<sup>2</sup>/yrOK

#### 2 Fabric U-values

| Element       | Average          | Highest          |    |
|---------------|------------------|------------------|----|
| External wall | 0.24 (max. 0.30) | 0.24 (max. 0.70) | OK |
| Party wall    | 0.00 (max. 0.20) | -                | OK |
| Floor         | 0.11 (max. 0.25) | 0.11 (max. 0.70) | OK |
| Roof          | 0.10 (max. 0.20) | 0.10 (max. 0.35) | OK |
| Openings      | 1.30 (max. 2.00) | 1.30 (max. 3.30) | OK |

#### 2a Thermal bridging

Thermal bridging calculated using user-specified y-value of 0.031

#### 3 Air permeability

Air permeability at 50 pascals: 5.00 (design value)  
Maximum 10.0 OK

#### 4 Heating efficiency

Main heating system: Boiler system with radiators or underfloor - Mains gas  
Data from database  
Ideal LOGIC COMBI ESP1 35  
Combi boiler  
Efficiency: 89.6% SEDBUK2009  
Minimum: 88.0% OK

#### Secondary heating system:

None

#### 5 Cylinder insulation

Hot water storage No cylinder

#### 6 Controls

Space heating controls: Time and temperature zone control OK

#### Hot water controls:

No cylinder

#### Boiler interlock

Yes OK

#### 7 Low energy lights

Percentage of fixed lights with low-energy fittings:100%  
Minimum 75% OK

#### 8 Mechanical ventilation

Continuous extract system (decentralised)  
Specific fan power: 0.1600 0.1600  
Maximum 0.7 OK

#### 9 Summertime temperature

Overheating risk (Southern England): Slight OK

#### Based on:

Overshading:  
Average  
Windows facing North East: 10.23 m<sup>2</sup>, No overhang  
Windows facing South East: 1.92 m<sup>2</sup>, No overhang  
Windows facing South West: 5.38 m<sup>2</sup>, No overhang  
Air change rate: 4.00 ach  
Blinds/curtains: None

#### 10 Key features

Party wall U-value 0.00 W/m<sup>2</sup>K  
Roof U-value 0.10 W/m<sup>2</sup>K  
Floor U-value 0.11 W/m<sup>2</sup>K  
Thermal bridging y-value 0.031 W/m<sup>2</sup>K

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)              | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|-----------------------------------|-----------------------------|
| Ground floor                                           | 46.0300 (1b)              | x 2.3500 (2b)                     | = 108.1705 (1b) - (3b)      |
| First floor                                            | 46.0300 (1c)              | x 2.5500 (2c)                     | = 117.3765 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.0600                   |                                   | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = | 225.5470 (5)                |

#### 2. Ventilation rate

|                                                      |                              |        |        |        | main<br>heating | +      | secondary<br>heating | +      | other  | =      | total                       | m3 per hour  |
|------------------------------------------------------|------------------------------|--------|--------|--------|-----------------|--------|----------------------|--------|--------|--------|-----------------------------|--------------|
| Number of chimneys                                   |                              |        |        |        | 0               | +      | 0                    | +      | 0      | =      | 0 * 40 =                    | 0.0000 (6a)  |
| Number of open flues                                 |                              |        |        |        | 0               | +      | 0                    | +      | 0      | =      | 0 * 20 =                    | 0.0000 (6b)  |
| Number of intermittent 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)+(7a)+(7b)+(7c) = |        |        |        |                 |        |                      |        |        |        | 0.0000 / (5) =              | 0.0000 (8)   |
| Pressure test                                        |                              |        |        |        |                 |        |                      |        |        |        | Yes                         |              |
| Measured/design AP50                                 |                              |        |        |        |                 |        |                      |        |        |        | 5.0000                      |              |
| Infiltration rate                                    |                              |        |        |        |                 |        |                      |        |        |        | 0.2500                      | (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) =        | 0.2125 (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) |
|                                                      | 0.2709                       | 0.2656 | 0.2603 | 0.2338 | 0.2284          | 0.2019 | 0.2019               | 0.1966 | 0.2125 | 0.2284 | 0.2391                      | 0.2497 (22b) |
| Mechanical extract ventilation - decentralised       |                              |        |        |        |                 |        |                      |        |        |        |                             |              |
| If mechanical ventilation:                           | 0.5000 (23a)                 |        |        |        |                 |        |                      |        |        |        |                             |              |
| Effective ac                                         | 0.5209                       | 0.5156 | 0.5103 | 0.5000 | 0.5000          | 0.5000 | 0.5000               | 0.5000 | 0.5000 | 0.5000 | 0.5000                      | 0.5000 (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  |                |                |                |                |                     |
|---------------------------------------------------------------------|----------------|----------------|----------------------|------------------|----------------|-------------------|----------------|----------------|----------------|----------------|----------------|---------------------|
| Opening Type 1                                                      |                |                | 2.1200               | 1.3000           | 2.7560         |                   | (26)           |                |                |                |                |                     |
| Opening Type 2 (Uw = 1.30)                                          |                |                | 17.5300              | 1.2357           | 21.6625        |                   | (27)           |                |                |                |                |                     |
| Heat Loss Floor 1                                                   |                |                | 46.0300              | 0.1100           | 5.0633         |                   | (28a)          |                |                |                |                |                     |
| External Wall 1                                                     | 128.7700       | 19.6500        | 109.1200             | 0.2400           | 26.1888        |                   | (29a)          |                |                |                |                |                     |
| External Roof 1                                                     | 46.0300        |                | 46.0300              | 0.1000           | 4.6030         |                   | (30)           |                |                |                |                |                     |
| Total net area of external elements Aum(A, m2)                      |                |                | 220.8300             |                  |                |                   | (31)           |                |                |                |                |                     |
| Fabric heat loss, W/K = Sum (A x U)                                 |                |                | (26)...(30) + (32) = |                  | 60.2736        |                   | (33)           |                |                |                |                |                     |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |                |                |                      |                  |                |                   | 250.0000 (35)  |                |                |                |                |                     |
| Thermal bridges (User defined value 0.031 * total exposed area)     |                |                |                      |                  |                |                   | 6.8457 (36)    |                |                |                |                |                     |
| Total fabric heat loss                                              |                |                |                      |                  |                | (33) + (36) =     | 67.1194 (37)   |                |                |                |                |                     |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                      |                  |                |                   |                |                |                |                |                |                     |
| (38)m                                                               | Jan<br>38.7736 | Feb<br>38.3782 | Mar<br>37.9828       | Apr<br>37.2153   | May<br>37.2153 | Jun<br>37.2153    | Jul<br>37.2153 | Aug<br>37.2153 | Sep<br>37.2153 | Oct<br>37.2153 | Nov<br>37.2153 | Dec<br>37.2153 (38) |
| Heat transfer coeff                                                 | 105.8930       | 105.4976       | 105.1022             | 104.3346         | 104.3346       | 104.3346          | 104.3346       | 104.3346       | 104.3346       | 104.3346       | 104.3346       | 104.3346 (39)       |
| Average = Sum(39)m / 12 =                                           |                |                |                      |                  |                |                   |                |                |                |                |                | 104.6254 (39)       |
| HLP                                                                 | Jan<br>1.1503  | Feb<br>1.1460  | Mar<br>1.1417        | Apr<br>1.1333    | May<br>1.1333  | Jun<br>1.1333     | Jul<br>1.1333  | Aug<br>1.1333  | Sep<br>1.1333  | Oct<br>1.1333  | Nov<br>1.1333  | Dec<br>1.1333 (40)  |
| HLP (average)                                                       |                |                |                      |                  |                |                   |                |                |                |                |                | 1.1365 (40)         |
| Days in month                                                       | 31             | 28             | 31                   | 30               | 31             | 30                | 31             | 31             | 30             | 31             | 30             | 31 (41)             |

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

|                                          |          |          |          |          |          |          |         |          |          |                    |          |                |
|------------------------------------------|----------|----------|----------|----------|----------|----------|---------|----------|----------|--------------------|----------|----------------|
| Assumed occupancy                        |          |          |          |          |          |          |         |          |          |                    |          | 2.6529 (42)    |
| Average daily hot water use (litres/day) |          |          |          |          |          |          |         |          |          |                    |          | 97.2059 (43)   |
|                                          | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul     | Aug      | Sep      | Oct                | Nov      | Dec            |
| Daily hot water use                      | 106.9265 | 103.0382 | 99.1500  | 95.2618  | 91.3735  | 87.4853  | 87.4853 | 91.3735  | 95.2618  | 99.1500            | 103.0382 | 106.9265 (44)  |
| Energy conte                             | 158.5689 | 138.6854 | 143.1109 | 124.7675 | 119.7174 | 103.3070 | 95.7291 | 109.8506 | 111.1626 | 129.5492           | 141.4131 | 153.5655 (45)  |
| Energy content (annual)                  |          |          |          |          |          |          |         |          |          | Total = Sum(45)m = |          | 1529.4272 (45) |
| Distribution loss (46)m = 0.15 x (45)m   |          |          |          |          |          |          |         |          |          |                    |          |                |
|                                          | 23.7853  | 20.8028  | 21.4666  | 18.7151  | 17.9576  | 15.4961  | 14.3594 | 16.4776  | 16.6744  | 19.4324            | 21.2120  | 23.0348 (46)   |
| Water storage loss:                      |          |          |          |          |          |          |         |          |          |                    |          |                |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Total storage 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 (56)   |
| If cylinder contains dedicated solar storage                    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (57)   |
| Combi loss                                                      | 14.1371  | 12.7581  | 14.0971  | 13.5981  | 14.0191  | 13.5297  | 13.9576  | 13.9975  | 13.5669  | 14.0648  | 13.6522  | 14.1251 (61)  |
| Total heat required for water heating calculated for each month | 172.7060 | 151.4435 | 157.2080 | 138.3656 | 133.7365 | 116.8367 | 109.6867 | 123.8480 | 124.7295 | 143.6141 | 155.0653 | 167.6906 (62) |
| 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 (63)   |
| Output from w/h                                                 | 172.7060 | 151.4435 | 157.2080 | 138.3656 | 133.7365 | 116.8367 | 109.6867 | 123.8480 | 124.7295 | 143.6141 | 155.0653 | 167.6906 (64) |
| Heat gains from water heating, kWh/month                        | 56.2584  | 49.3024  | 51.1086  | 44.8847  | 43.3108  | 37.7320  | 35.3193  | 40.0247  | 40.3533  | 46.5913  | 50.4329  | 54.5918 (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                                                                               | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 21.9276   | 19.4759   | 15.8389   | 11.9911   | 8.9635    | 7.5673    | 8.1768    | 10.6285   | 14.2655   | 18.1133   | 21.1410   | 22.5371   | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 242.8169  | 245.3366  | 238.9871  | 225.4698  | 208.4065  | 192.3695  | 181.6557  | 179.1361  | 185.4856  | 199.0029  | 216.0662  | 232.1032  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | (69) |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | (71) |
| Water heating gains (Table 5)                                                       | 75.6162   | 73.3667   | 68.6944   | 62.3399   | 58.2135   | 52.4056   | 47.4722   | 53.7966   | 56.0462   | 62.6228   | 70.0457   | 73.3761   | (72) |
| Total internal gains                                                                | 406.1540  | 403.9724  | 389.3136  | 365.5939  | 341.3766  | 318.1356  | 303.0979  | 309.3544  | 321.5905  | 345.5322  | 373.0460  | 393.8096  | (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 |      |
|-----------|------------|--------------------------------|------------------------------|------------------------------|--------|------------------------------|------------|------|
| Northeast | 10.2300    | 11.2829                        | 0.7200                       |                              | 0.7000 | 0.7700                       | 40.3145    | (75) |
| Southeast | 1.9200     | 36.7938                        | 0.7200                       |                              | 0.7000 | 0.7700                       | 24.6740    | (77) |
| Southwest | 5.3800     | 36.7938                        | 0.7200                       |                              | 0.7000 | 0.7700                       | 69.1387    | (79) |

|             |          |          |          |          |          |          |          |          |          |          |          |          |      |
|-------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|------|
| Solar gains | 134.1272 | 241.8592 | 366.4908 | 513.7182 | 629.8240 | 649.2055 | 615.9423 | 525.6628 | 416.8991 | 276.8961 | 163.0921 | 113.2070 | (83) |
| Total gains | 540.2812 | 645.8316 | 755.8044 | 879.3121 | 971.2006 | 967.3411 | 919.0402 | 835.0171 | 738.4896 | 622.4283 | 536.1382 | 507.0166 | (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                                                                         | 60.3728 | 60.5991 | 60.8270 | 61.2745 | 61.2745 | 61.2745 | 61.2745 | 61.2745 | 61.2745 | 61.2745 | 61.2745 | 61.2745 |              |
| alpha                                                                       | 5.0249  | 5.0399  | 5.0551  | 5.0850  | 5.0850  | 5.0850  | 5.0850  | 5.0850  | 5.0850  | 5.0850  | 5.0850  | 5.0850  |              |
| util living area                                                            | 0.9982  | 0.9952  | 0.9852  | 0.9457  | 0.8353  | 0.6540  | 0.4921  | 0.5596  | 0.8248  | 0.9739  | 0.9960  | 0.9987  | (86)         |
| MIT                                                                         | 19.7462 | 19.9222 | 20.2037 | 20.5591 | 20.8372 | 20.9641 | 20.9930 | 20.9871 | 20.8866 | 20.5099 | 20.0624 | 19.7245 | (87)         |
| Th 2                                                                        | 19.9600 | 19.9635 | 19.9669 | 19.9737 | 19.9737 | 19.9737 | 19.9737 | 19.9737 | 19.9737 | 19.9737 | 19.9737 | 19.9737 | (88)         |
| util rest of house                                                          | 0.9976  | 0.9936  | 0.9800  | 0.9264  | 0.7828  | 0.5638  | 0.3812  | 0.4424  | 0.7492  | 0.9610  | 0.9943  | 0.9983  | (89)         |
| MIT 2                                                                       | 18.2876 | 18.5468 | 18.9573 | 19.4630 | 19.8194 | 19.9508 | 19.9712 | 19.9685 | 19.8845 | 19.4044 | 18.7596 | 18.2657 | (90)         |
| Living area fraction                                                        | 18.5481 | 18.7924 | 19.1799 | 19.6587 | 20.0011 | 20.1318 | 20.1537 | 20.1504 | 20.0635 | 19.6018 | 18.9923 | 18.5263 | (92)         |
| MIT                                                                         | 18.5481 | 18.7924 | 19.1799 | 19.6587 | 20.0011 | 20.1318 | 20.1537 | 20.1504 | 20.0635 | 19.6018 | 18.9923 | 18.5263 | (92)         |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |         |         | -0.1500 |              |
| adjusted MIT                                                                | 18.3981 | 18.6424 | 19.0299 | 19.5087 | 19.8511 | 19.9818 | 20.0037 | 20.0004 | 19.9135 | 19.4518 | 18.8423 | 18.3763 | (93)         |

#### 8. Space heating requirement

|                      |           |           |           |           |          |          |          |          |          |              |           |           |       |
|----------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|--------------|-----------|-----------|-------|
| Utilisation          | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct          | Nov       | Dec       |       |
| Useful gains         | 0.9961    | 0.9905    | 0.9733    | 0.9153    | 0.7757   | 0.5646   | 0.3845   | 0.4456   | 0.7441   | 0.9518       | 0.9915    | 0.9972    | (94)  |
| Ext temp.            | 538.1898  | 639.7026  | 735.6589  | 804.8737  | 753.3158 | 546.1204 | 353.3864 | 372.0632 | 549.4869 | 592.4225     | 531.5973  | 505.5744  | (95)  |
| Heat loss rate W     | 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)  |
| Month fracti         | 1492.8908 | 1449.7899 | 1316.9170 | 1106.8598 | 850.4459 | 561.5048 | 355.1231 | 375.6490 | 606.5448 | 923.5511     | 1225.1273 | 1479.0743 | (97)  |
| Space heating kWh    | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000   | 1.0000       | 1.0000    | 1.0000    | (97a) |
| Space heating        | 710.2976  | 544.3787  | 432.4561  | 217.4300  | 72.2648  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 246.3597     | 499.3417  | 724.2839  | (98)  |
| Space heating per m2 |           |           |           |           |          |          |          |          |          |              |           | 3446.8124 | (98)  |
|                      |           |           |           |           |          |          |          |          |          | (98) / (4) = |           | 37.4409   | (99)  |

#### 8c. Space cooling requirement

Not applicable

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



CALCULATION OF DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

### 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 %)                                         |          |          |          |          |          |          |          |          |          |          |          |           | 90.5000 (206)   |
| Efficiency of secondary/supplementary heating system, %                                  |          |          |          |          |          |          |          |          |          |          |          |           | 0.0000 (208)    |
| Space heating requirement                                                                |          |          |          |          |          |          |          |          |          |          |          |           | 3808.6325 (211) |
| Jan                                                                                      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec      |           |                 |
| Space heating requirement                                                                | 710.2976 | 544.3787 | 432.4561 | 217.4300 | 72.2648  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 246.3597 | 499.3417 | 724.2839  | (98)            |
| Space heating efficiency (main heating system 1)                                         | 90.5000  | 90.5000  | 90.5000  | 90.5000  | 90.5000  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 90.5000  | 90.5000  | 90.5000   | (210)           |
| Space heating fuel (main heating system)                                                 | 784.8592 | 601.5234 | 477.8520 | 240.2542 | 79.8507  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 272.2206 | 551.7587 | 800.3137  | (211)           |
| Water heating requirement                                                                | 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                                                                | 172.7060 | 151.4435 | 157.2080 | 138.3656 | 133.7365 | 116.8367 | 109.6867 | 123.8480 | 124.7295 | 143.6141 | 155.0653 | 167.6906  | (64)            |
| Efficiency of water heater (217)m                                                        | 89.8558  | 89.7837  | 89.6241  | 89.2281  | 88.3965  | 87.3000  | 87.3000  | 87.3000  | 87.3000  | 89.2946  | 89.7207  | 89.8806   | (216)           |
| Fuel for water heating, kWh/month                                                        | 192.2035 | 168.6759 | 175.4081 | 155.0696 | 151.2917 | 133.8336 | 125.6434 | 141.8649 | 142.8746 | 160.8317 | 172.8311 | 186.5704  | (219)           |
| Water heating fuel used                                                                  |          |          |          |          |          |          |          |          |          |          |          | 1907.0985 | (219)           |
| Annual totals kWh/year                                                                   |          |          |          |          |          |          |          |          |          |          |          |           |                 |
| Space heating fuel - main system                                                         |          |          |          |          |          |          |          |          |          |          |          | 3808.6325 | (211)           |
| Space heating fuel - secondary                                                           |          |          |          |          |          |          |          |          |          |          |          | 0.0000    | (215)           |
| Electricity for pumps and fans:                                                          |          |          |          |          |          |          |          |          |          |          |          |           |                 |
| (MEV)Decentralised, Database: total watage = 5.3360, total flow = 29.0000, SFP = 0.1840) |          |          |          |          |          |          |          |          |          |          |          |           |                 |
| mechanical ventilation fans (SFP = 0.1840)                                               |          |          |          |          |          |          |          |          |          |          |          |           | 50.6308 (230a)  |
| central heating pump                                                                     |          |          |          |          |          |          |          |          |          |          |          |           | 30.0000 (230c)  |
| main heating flue fan                                                                    |          |          |          |          |          |          |          |          |          |          |          |           | 45.0000 (230e)  |
| Total electricity for the above, kWh/year                                                |          |          |          |          |          |          |          |          |          |          |          |           | 125.6308 (231)  |
| Electricity for lighting (calculated in Appendix L)                                      |          |          |          |          |          |          |          |          |          |          |          |           | 387.2490 (232)  |
| Total delivered energy for all uses                                                      |          |          |          |          |          |          |          |          |          |          |          |           | 6228.6108 (238) |

### 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               | 3808.6325          | 0.2160                        | 822.6646 (261)           |
| Space heating - secondary                   | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)                  | 1907.0985          | 0.2160                        | 411.9333 (264)           |
| Space and water heating                     |                    |                               | 1234.5979 (265)          |
| Pumps and fans                              | 125.6308           | 0.5190                        | 65.2024 (267)            |
| Energy for lighting                         | 387.2490           | 0.5190                        | 200.9822 (268)           |
| Total CO2, kg/year                          |                    |                               | 1500.7825 (272)          |
| Dwelling Carbon Dioxide Emission Rate (DER) |                    |                               | 16.3000 (273)            |

### 16 CO2 EMISSIONS ASSOCIATED WITH APPLIANCES AND COOKING AND SITE-WIDE ELECTRICITY GENERATION TECHNOLOGIES

|                                                                                 |  |     |             |
|---------------------------------------------------------------------------------|--|-----|-------------|
| DER                                                                             |  |     | 16.3000 ZC1 |
| Total Floor Area                                                                |  | TFA | 92.0600     |
| Assumed number of occupants                                                     |  | N   | 2.6529      |
| CO2 emission factor in Table 12 for electricity displaced from grid             |  | EF  | 0.5190      |
| CO2 emissions from appliances, equation (L14)                                   |  |     | 15.6298 ZC2 |
| CO2 emissions from cooking, equation (L16)                                      |  |     | 1.9842 ZC3  |
| Total CO2 emissions                                                             |  |     | 33.9141 ZC4 |
| Residual CO2 emissions offset from biofuel CHP                                  |  |     | 0.0000 ZC5  |
| Additional allowable electricity generation, kWh/m²/year                        |  |     | 0.0000 ZC6  |
| Resulting CO2 emissions offset from additional allowable electricity generation |  |     | 0.0000 ZC7  |
| Net CO2 emissions                                                               |  |     | 33.9141 ZC8 |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF TARGET EMISSIONS 09 Jan 2014

#### 1. Overall dwelling dimensions

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)              | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|-----------------------------------|-----------------------------|
| Ground floor                                           | 46.0300 (1b)              | x 2.3500 (2b)                     | = 108.1705 (1b) - (3b)      |
| First floor                                            | 46.0300 (1c)              | x 2.5500 (2c)                     | = 117.3765 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 92.0600                   |                                   | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = | 225.5470 (5)                |

#### 2. Ventilation rate

|                                                      | main<br>heating              | +      | secondary<br>heating | +      | other  | =      | total                       | m3 per hour  |        |        |        |              |
|------------------------------------------------------|------------------------------|--------|----------------------|--------|--------|--------|-----------------------------|--------------|--------|--------|--------|--------------|
| Number of chimneys                                   | 0                            | +      | 0                    | +      | 0      | =      | 0 * 40 =                    | 0.0000 (6a)  |        |        |        |              |
| Number of open flues                                 | 0                            | +      | 0                    | +      | 0      | =      | 0 * 20 =                    | 0.0000 (6b)  |        |        |        |              |
| Number of intermittent fans                          |                              |        |                      |        |        |        | 3 * 10 =                    | 30.0000 (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)+(7a)+(7b)+(7c) = |        |                      |        |        |        | 30.0000 / (5) =             | 0.1330 (8)   |        |        |        |              |
| Pressure test                                        |                              |        |                      |        |        |        | Yes                         |              |        |        |        |              |
| Measured/design AP50                                 |                              |        |                      |        |        |        | 5.0000                      |              |        |        |        |              |
| Infiltration rate                                    |                              |        |                      |        |        |        | 0.3830                      | (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) =        | 0.3256 (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                                      | 0.4151                       | 0.4069 | 0.3988               | 0.3581 | 0.3500 | 0.3093 | 0.3093                      | 0.3011       | 0.3256 | 0.3500 | 0.3663 | 0.3825 (22b) |
| Effective ac                                         | 0.5861                       | 0.5828 | 0.5795               | 0.5641 | 0.5612 | 0.5478 | 0.5478                      | 0.5453       | 0.5530 | 0.5612 | 0.5671 | 0.5732 (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                                                     |                |                | 2.1200         | 1.0000                | 2.1200         |                   |                | (26)           |                |                |                |                |      |
| TER Opening Type (Uw = 1.40)                                        |                |                | 17.5300        | 1.3258                | 23.2405        |                   |                | (27)           |                |                |                |                |      |
| Heat Loss Floor 1                                                   |                |                | 46.0300        | 0.1300                | 5.9839         |                   |                | (28a)          |                |                |                |                |      |
| External Wall 1                                                     | 128.7700       | 19.6500        | 109.1200       | 0.1800                | 19.6416        |                   |                | (29a)          |                |                |                |                |      |
| External Roof 1                                                     | 46.0300        |                | 46.0300        | 0.1300                | 5.9839         |                   |                | (30)           |                |                |                |                |      |
| Total net area of external elements Aum(A, m2)                      |                |                | 220.8300       |                       |                |                   |                | (31)           |                |                |                |                |      |
| Fabric heat loss, W/K = Sum (A x U)                                 |                |                |                | (26)... (30) + (32) = | 56.9699        |                   |                | (33)           |                |                |                |                |      |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |                |                |                |                       |                |                   |                | 250.0000 (35)  |                |                |                |                |      |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |                |                |                |                       |                |                   | 0.0000         | (36)           |                |                |                |                |      |
| Total fabric heat loss                                              |                |                |                |                       |                | (33) + (36) =     | 56.9699        | (37)           |                |                |                |                |      |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                |                       |                |                   |                |                |                |                |                |                |      |
| (38)m                                                               | Jan<br>43.6273 | Feb<br>43.3784 | Mar<br>43.1343 | Apr<br>41.9880        | May<br>41.7735 | Jun<br>40.7751    | Jul<br>40.7751 | Aug<br>40.5902 | Sep<br>41.1596 | Oct<br>41.7735 | Nov<br>42.2074 | Dec<br>42.6610 | (38) |
| Heat transfer coeff                                                 | 100.5973       | 100.3483       | 100.1042       | 98.9579               | 98.7434        | 97.7450           | 97.7450        | 97.5601        | 98.1296        | 98.7434        | 99.1773        | 99.6309        | (39) |
| Average = Sum(39)m / 12 =                                           |                |                |                |                       |                |                   |                |                |                |                |                | 98.9569        | (39) |
| HLP                                                                 | Jan<br>1.0927  | Feb<br>1.0900  | Mar<br>1.0874  | Apr<br>1.0749         | May<br>1.0726  | Jun<br>1.0618     | Jul<br>1.0618  | Aug<br>1.0597  | Sep<br>1.0659  | Oct<br>1.0726  | Nov<br>1.0773  | Dec<br>1.0822  | (40) |
| HLP (average)                                                       |                |                |                |                       |                |                   |                |                |                |                |                | 1.0749         | (40) |
| Days in month                                                       | 31             | 28             | 31             | 30                    | 31             | 30                | 31             | 31             | 30             | 31             | 30             | 31             | (41) |

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

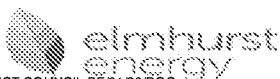
|                                              |              |              |             |             |             |             |             |             |             |                    |              |                   |
|----------------------------------------------|--------------|--------------|-------------|-------------|-------------|-------------|-------------|-------------|-------------|--------------------|--------------|-------------------|
| Assumed occupancy                            |              |              |             |             |             |             |             |             |             |                    |              | 2.6529 (42)       |
| Average daily hot water use (litres/day)     |              |              |             |             |             |             |             |             |             |                    |              | 97.2059 (43)      |
| Daily hot water use                          | Jan 106.9265 | Feb 103.0382 | Mar 99.1500 | Apr 95.2618 | May 91.3735 | Jun 87.4853 | Jul 87.4853 | Aug 91.3735 | Sep 95.2618 | Oct 99.1500        | Nov 103.0382 | Dec 106.9265 (44) |
| Energy conte                                 | 158.5689     | 138.6854     | 143.1109    | 124.7675    | 119.7174    | 103.3070    | 95.7291     | 109.8506    | 111.1626    | 129.5492           | 141.4131     | 153.5655 (45)     |
| Energy content (annual)                      |              |              |             |             |             |             |             |             |             | Total = Sum(45)m = |              | 1529.4272 (45)    |
| Distribution loss (46)m = 0.15 x (45)m       |              |              |             |             |             |             |             |             |             |                    |              |                   |
| 23.7853                                      | 20.8028      | 21.4666      | 18.7151     | 17.9576     | 15.4961     | 14.3594     | 16.4776     | 16.6744     | 19.4324     | 21.2120            | 23.0348      | (46)              |
| Water storage loss:                          |              |              |             |             |             |             |             |             |             |                    |              |                   |
| Total storage 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 (56)       |
| If cylinder contains dedicated solar storage |              |              |             |             |             |             |             |             |             |                    |              |                   |

Regs Region: England

Elmhurst Energy Systems

SAP2012 Calculator (Design

System) version 4.08r10



# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| 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 (57)   |
| Total heat required for water heating calculated for each month | 50.9589  | 46.0274  | 50.5258  | 46.9784  | 46.5630  | 43.1434  | 44.5816  | 46.5630  | 46.9784  | 50.5258  | 49.3151  | 50.9589 (61)  |
| Solar input                                                     | 209.5278 | 184.7128 | 193.6366 | 171.7459 | 166.2804 | 146.4505 | 140.3107 | 156.4135 | 158.1410 | 180.0750 | 190.7282 | 204.5244 (62) |
| Output from w/h                                                 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (63)   |
| Heat gains from water heating, kWh/month                        | 65.4639  | 57.6197  | 60.2158  | 53.2298  | 51.4468  | 45.1354  | 42.9753  | 48.1661  | 48.7062  | 55.7066  | 59.3486  | 63.8003 (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) |
| (66)m                                                                               | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | 132.6440  | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 21.9276   | 19.4759   | 15.8389   | 11.9911   | 8.9635    | 7.5673    | 8.1768    | 10.6285   | 14.2655   | 18.1133   | 21.1410   | 22.5371   | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 242.8169  | 245.3366  | 238.9871  | 225.4698  | 208.4065  | 192.3695  | 181.6557  | 179.1361  | 185.4856  | 199.0029  | 216.0662  | 232.1032  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | 36.2644   | (69) |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | -106.1152 | (71) |
| Water heating gains (Table 5)                                                       | 87.9891   | 85.7436   | 80.9352   | 73.9303   | 69.1489   | 62.6881   | 57.7625   | 64.7393   | 67.6474   | 74.8744   | 82.4287   | 85.7530   | (72) |
| Total internal gains                                                                | 418.5269  | 416.3494  | 401.5544  | 377.1843  | 352.3121  | 328.4181  | 313.3882  | 320.2971  | 333.1917  | 357.7839  | 385.4290  | 406.1865  | (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   |          |               |
|-------------|--|--|--|--|------------|--------------------------------|-----------------------------------|------------------------------------|----------|----------|------------------------------|----------|----------|--------------|----------|---------------|
| <hr/>       |  |  |  |  |            |                                |                                   |                                    |          |          |                              |          |          |              |          |               |
| Northeast   |  |  |  |  | 10.2300    | 11.2829                        | 0.6300                            | 0.7000                             |          |          | 0.7700                       |          |          | 35.2752 (75) |          |               |
| Southeast   |  |  |  |  | 1.9200     | 36.7938                        | 0.6300                            | 0.7000                             |          |          | 0.7700                       |          |          | 21.5898 (77) |          |               |
| Southwest   |  |  |  |  | 5.3800     | 36.7938                        | 0.6300                            | 0.7000                             |          |          | 0.7700                       |          |          | 60.4963 (79) |          |               |
| <hr/>       |  |  |  |  |            |                                |                                   |                                    |          |          |                              |          |          |              |          |               |
| Solar gains |  |  |  |  | 117.3613   | 211.6268                       | 320.6795                          | 449.5034                           | 551.0960 | 568.0549 | 538.9495                     | 459.9549 | 364.7867 | 242.2841     | 142.7056 | 99.0561 (83)  |
| Total gains |  |  |  |  | 535.8882   | 627.9762                       | 722.2339                          | 826.6877                           | 903.4080 | 896.4730 | 852.3378                     | 780.2520 | 697.9784 | 600.0680     | 528.1346 | 505.2427 (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                                                                         | 63.5510 | 63.7087 | 63.8640 | 64.6038 | 64.7441 | 65.4055 | 65.4055 | 65.5294 | 65.1491 | 64.7441 | 64.4609 | 64.1674 |              |
| alpha                                                                       | 5.2367  | 5.2472  | 5.2576  | 5.3069  | 5.3163  | 5.3604  | 5.3604  | 5.3686  | 5.3433  | 5.3163  | 5.2974  | 5.2778  |              |
| util living area                                                            | 0.9983  | 0.9957  | 0.9870  | 0.9520  | 0.8485  | 0.6637  | 0.4981  | 0.5622  | 0.8293  | 0.9753  | 0.9962  | 0.9987  | (86)         |
| MIT                                                                         | 19.8196 | 19.9785 | 20.2378 | 20.5756 | 20.8429 | 20.9683 | 20.9943 | 20.9895 | 20.8982 | 20.5430 | 20.1187 | 19.7923 | (87)         |
| Th 2                                                                        | 20.0068 | 20.0090 | 20.0112 | 20.0214 | 20.0233 | 20.0322 | 20.0322 | 20.0338 | 20.0288 | 20.0233 | 20.0194 | 20.0154 | (88)         |
| util rest of house                                                          | 0.9977  | 0.9942  | 0.9824  | 0.9348  | 0.7993  | 0.5772  | 0.3920  | 0.4508  | 0.7570  | 0.9632  | 0.9946  | 0.9983  | (89)         |
| MIT 2                                                                       | 18.4283 | 18.6618 | 19.0394 | 19.5248 | 19.8721 | 20.0116 | 20.0301 | 20.0296 | 19.9477 | 19.4891 | 18.8746 | 18.3946 | (90)         |
| Living area fraction                                                        | 18.6768 | 18.8969 | 19.2534 | 19.7124 | 20.0455 | 20.1825 | 20.2023 | 20.2010 | 20.1174 | 19.6773 | 19.0968 | 18.6442 | (91)         |
| MIT                                                                         | 18.6768 | 18.8969 | 19.2534 | 19.7124 | 20.0455 | 20.1825 | 20.2023 | 20.2010 | 20.1174 | 19.6773 | 19.0968 | 18.6442 | (92)         |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |         |         | 0.0000  |              |
| adjusted MIT                                                                | 18.6768 | 18.8969 | 19.2534 | 19.7124 | 20.0455 | 20.1825 | 20.2023 | 20.2010 | 20.1174 | 19.6773 | 19.0968 | 18.6442 | (93)         |

#### 8. Space heating requirement

|                      |           |           |           |           |          |          |          |          |          |          |           |           |       |
|----------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------|
| Utilisation          | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec       |       |
| Useful gains         | 534.0218  | 622.8592  | 706.0832  | 767.1806  | 723.2656 | 530.0781 | 350.2905 | 367.2069 | 533.5769 | 574.5495 | 524.1354  | 503.9333  | (94)  |
| 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     | 1446.2619 | 1404.5654 | 1276.6660 | 1069.9759 | 824.0617 | 545.6573 | 352.1050 | 370.8252 | 590.4850 | 896.3200 | 1189.8082 | 1439.0928 | (97)  |
| Month fracti         | 1.0000    | 1.0000    | 1.0000    | 1.0000    | 1.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 1.0000   | 1.0000    | 1.0000    | (97a) |
| Space heating kWh    | 678.7066  | 525.3066  | 424.5137  | 218.0126  | 74.9923  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 239.3973 | 479.2844  | 695.7587  | (98)  |
| Space heating        |           |           |           |           |          |          |          |          |          |          |           | 3335.9722 | (98)  |
| Space heating per m2 |           |           |           |           |          |          |          |          |          |          |           | 36.2369   | (99)  |

#### 8c. Space cooling requirement

Not applicable

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

#### 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 %)                      |          |          |          |          |          |          |          |          |          |          |          | 93.4000 (206)   |
| Efficiency of secondary/supplementary heating system, %               |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (208)    |
| Space heating requirement                                             |          |          |          |          |          |          |          |          |          |          |          | 3571.7047 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec             |
| Space heating requirement                                             | 678.7066 | 525.3066 | 424.5137 | 218.0126 | 74.9923  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 239.3973 | 479.2844 | 695.7587 (98)   |
| Space heating efficiency (main heating system 1)                      | 93.4000  | 93.4000  | 93.4000  | 93.4000  | 93.4000  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 93.4000  | 93.4000  | 93.4000 (210)   |
| Space heating fuel (main heating system)                              | 726.6666 | 562.4267 | 454.5114 | 233.4182 | 80.2915  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 256.3140 | 513.1524 | 744.9236 (211)  |
| Water heating requirement                                             | 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                                             | 209.5278 | 184.7128 | 193.6366 | 171.7459 | 166.2804 | 146.4505 | 140.3107 | 156.4135 | 158.1410 | 180.0750 | 190.7282 | 204.5244 (64)   |
| Efficiency of water heater (217)m                                     | 87.7951  | 87.5357  | 86.9732  | 85.6528  | 83.1889  | 80.3000  | 80.3000  | 80.3000  | 80.3000  | 85.7689  | 87.2752  | 80.3000 (216)   |
| Fuel for water heating, kWh/month                                     | 238.6554 | 211.0142 | 222.6393 | 200.5141 | 199.8830 | 182.3792 | 174.7331 | 194.7865 | 196.9377 | 209.9538 | 218.5366 | 87.8887 (217)   |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |          |          | 232.7085 (219)  |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |          |          | 2482.7414 (219) |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |          |          | 3571.7047 (211) |
| Space heating fuel - secondary                                        |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (215)    |
| Electricity for pumps and fans:                                       |          |          |          |          |          |          |          |          |          |          |          |                 |
| central heating pump                                                  |          |          |          |          |          |          |          |          |          |          |          | 30.0000 (230c)  |
| main heating flue fan                                                 |          |          |          |          |          |          |          |          |          |          |          | 45.0000 (230e)  |
| Total electricity for the above, kWh/year                             |          |          |          |          |          |          |          |          |          |          |          | 75.0000 (231)   |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |          |          |          |          |          |          |          | 387.2490 (232)  |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |          |          | 6516.6951 (238) |

#### 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                                                                     | 3571.7047          | 0.2160                        | 771.4882 (261)           |
| Space heating - secondary                                                                         | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)                                                                        | 2482.7414          | 0.2160                        | 536.2721 (264)           |
| Space and water heating                                                                           |                    |                               | 1307.7604 (265)          |
| Pumps and fans                                                                                    | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                                                                               | 387.2490           | 0.5190                        | 200.9822 (268)           |
| Total CO2, kg/m2/year                                                                             |                    |                               | 1547.6676 (272)          |
| Emissions per m2 for space and water heating                                                      |                    |                               | 14.2055 (272a)           |
| Fuel factor (mains gas)                                                                           |                    |                               | 1.0000                   |
| Emissions per m2 for lighting                                                                     |                    |                               | 2.1832 (272b)            |
| Emissions per m2 for pumps and fans                                                               |                    |                               | 0.4228 (272c)            |
| Target Carbon Dioxide Emission Rate (TER) = (14.2055 * 1.00) + 2.1832 + 0.4228, rounded to 2 d.p. |                    |                               | 16.8100 (273)            |

## Southern Energy Consultants Ltd

Suite 36, Liberty House  
The Enterprise Centre  
Greenham Business Park  
Newbury  
Berkshire  
RG19 6HS



**Southern Energy**  
Consultants  
Energy & Sustainability Solutions