



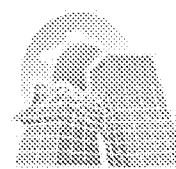
## LAND NORTH OF HOOK LANE - PAGHAM



# Energy Statement

17<sup>th</sup> March 2022

ARUN DISTRICT COUNCIL P/49/22/DOC  
SIX/16/00000000-3702/A



**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

17<sup>th</sup> March 2022

Report type:

Planning Application: Supporting Document

Revisions:

17/03/2022 - Rev A; Revised to reflect Policy ECC SP2 requirement of 10% reduction in energy demand from renewables in lieu of CO2 emissions, following correspondence from Arun DC

## Contents

|                 |                                                                                |    |
|-----------------|--------------------------------------------------------------------------------|----|
| <b>1.0</b>      | Introduction                                                                   | 3  |
| <b>2.0</b>      | Building Design, Carbon Dioxide Emissions and Energy Demand                    | 4  |
| <b>3.0</b>      | Conclusion                                                                     | 14 |
| <b>Appendix</b> |                                                                                | 16 |
|                 | SAP Calculation Examples (including best practice energy efficiency measures): |    |
|                 | Type Baker (Plot 92) with 0.75 kWp of solar PV output                          |    |
|                 | Type Mason (Plot 107) with 0.75 kWp of solar PV output                         |    |

## 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 26 of the outline planning consent (Ref: P/30/19/OUT, dated 2<sup>nd</sup> September 2019) for their development at Hook Lane, Pagham. In addition, a reserved matters application (Ref: P/132/20/RES) for the development received consent on 10<sup>th</sup> September 2021. The overall development is located within the Arun District Council authority boundary and includes the construction of up to 300 new dwellings of mixed type and tenure (30% affordable), a care home of up to 80 beds, D1 uses of up to 4,000 m<sup>2</sup>, a primary school, new access provision, new pedestrian and cycle links, open space provision, landscaping, habitat creation, drainage and associated infrastructure works.
- 1.2 This Statement first details the contents of condition 26 and its underpinning policy, before, in subsequent Sections, proceeding to detail the Applicant's comprehensive response with respect to the 300 proposed dwellings.

### Planning Condition 26

- 1.3 Planning Condition 26 states the following: *"At least 10% of the total predicted energy requirements for the development (taking into account energy efficiency measures) will be generated through renewable or low carbon energy generation on site. The Local Planning Authority will consider 'allowable solutions' where it is clearly demonstrated that the provision of on-site renewable or low carbon energy generation is unviable or unfeasible and where equivalent energy savings can be demonstrated. Details and a timetable of how this is to be achieved for the development hereby approved, including details of physical works on site, shall be submitted to and approved in writing by the Local Planning Authority before development of the dwellings hereby approved commences. The development shall be implemented in accordance with the approved details and timetable and will be retained as operational thereafter, unless otherwise agreed by the Local Planning Authority. "*
- 1.4 Condition 26 is justified through Policy ECC SP2 (Energy and Climate Change Mitigation) of Arun District Council's Local Plan (2018). 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. In addition, a Design Guide Supplementary Planning Document was adopted by Arun District Council in January 2021. Section K.01 reinforces

the 10% reduction target in Policy ECC SP2 and emphasises the importance of adhering to an energy hierarchy, whereby carbon dioxide emissions from new developments are reduced via energy efficiency measures prior to the introduction of renewable or low carbon energy generating technologies.

#### **Summary of Requirements**

- 1.5 This Statement will provide the Applicant's response to Policy ECC SP2, paying specific attention to the energy proposals for the site, which will utilise best practice energy efficiency techniques and renewable energy or low carbon technologies to reduce energy demand (after energy efficiency measures) by at least 10% per annum across the new development.

#### **Structure**

- 1.6 Section 2 of this Statement calculates the baseline emissions and corresponding baseline energy demand 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. Section 2 outlines the Applicant's best practice energy efficiency measures that will meet, and for most dwellings, better the emissions standard set by Part L1a. A feasibility study is then conducted to determine the most suitable renewable energy or low carbon technologies to deliver the sought-after 10% reduction in site-wide energy demand. In Section 3, a conclusion is provided, summarising projected emissions performance against the policy requirement for a 10% of energy demand to be satisfied via renewable energy or low carbon technologies.

## **2.0 Building Design, Carbon Dioxide Emissions and Energy Demand**

#### **Objectives of the energy strategy**

- 2.1 All dwellings will be designed and built to meet or better the current emissions standard set by Part L1a of Building Regulations (2013) respectively. In order to meet this standard, all dwellings will incorporate enhanced energy efficiency measures. Standard Assessment Procedure (SAP) calculations, as required by Building Regulations, have been carried out by Southern Energy Consultants on all proposed dwelling types. This was carried out with the following aims in mind:

- (a) To first establish a regulatory baseline standard for carbon dioxide emissions and corresponding energy demand in relation to the 300 proposed dwellings;
- (b) To use the baseline standard to calculate the 10% reduction in energy demand;
- (c) To appraise energy demand after energy efficiency measures in order to demonstrate the reduction in energy demand delivered in comparison to the regulatory baseline standard;
- (d) To understand the remaining reduction in energy demand that will be delivered through decentralised renewable or low carbon technologies in order to comply with Condition 26 and Policy ECC SP2.

### Energy demand baseline

- 2.2 A summary of the regulatory baseline calculation for the Hook Lane development is provided in Table 1:

**Table 1: Baseline carbon dioxide emissions and energy demand calculation for Hook Lane**

| Dwelling Type  | Baseline Carbon Dioxide Emissions (KgCO <sub>2</sub> /yr) | Energy Demand (kWh/yr) | Number of Dwellings | Total Energy Demand (kWh/yr) |
|----------------|-----------------------------------------------------------|------------------------|---------------------|------------------------------|
| <b>Private</b> |                                                           |                        |                     |                              |
| Slater         | 1,235                                                     | 4,767                  | 7                   | 33,370                       |
| Cooper         | 1,244                                                     | 4,802                  | 22                  | 105,640                      |
| Woodcarver     | 1,355                                                     | 5,230                  | 8                   | 41,842                       |
| Coiner         | 1,396                                                     | 5,389                  | 25                  | 134,714                      |
| Tailor         | 1,281                                                     | 4,945                  | 8                   | 39,557                       |
| Thespian       | 1,579                                                     | 6,095                  | 6                   | 36,570                       |
| Quilter        | 1,599                                                     | 6,172                  | 17                  | 104,926                      |
| Tanner         | 1,625                                                     | 6,273                  | 4                   | 25,090                       |
| Coppersmith    | 1,647                                                     | 6,357                  | 12                  | 76,289                       |
| Blemmere       | 1,647                                                     | 6,357                  | 4                   | 25,430                       |
| Framer         | 1,666                                                     | 6,431                  | 17                  | 109,323                      |
| Mason          | 1,676                                                     | 6,469                  | 17                  | 109,979                      |

|                             |       |       |            |                  |
|-----------------------------|-------|-------|------------|------------------|
| Sculptor                    | 1,844 | 7,118 | 5          | 35,589           |
| Bowyer                      | 2,020 | 7,797 | 15         | 116,958          |
| Goldsmith                   | 2,185 | 8,434 | 14         | 118,077          |
| Arkwright                   | 2,240 | 8,646 | 23         | 198,867          |
| Weaver                      | 2,410 | 9,303 | 6          | 55,816           |
| <b>Sub-total</b>            |       |       | <b>210</b> | <b>1,368,038</b> |
| <b>Affordable</b>           |       |       |            |                  |
| Souter                      | 1,046 | 4,767 | 18         | 85,808           |
| Glover                      | 1,187 | 4,802 | 18         | 86,433           |
| Baker                       | 1,524 | 5,230 | 16         | 83,685           |
| Romsey                      | 1,765 | 5,389 | 12         | 64,663           |
| Ploughwright                | 1,612 | 4,945 | 5          | 24,723           |
| Tilman                      | 1,596 | 6,095 | 15         | 91,424           |
| Cartographer                | 1,729 | 6,172 | 6          | 37,033           |
| <b>Sub-total</b>            |       |       | <b>90</b>  | <b>473,769</b>   |
| <b>TOTAL</b>                |       |       | <b>300</b> | <b>1,841,807</b> |
| <b>Average per dwelling</b> |       |       |            | <b>6,139</b>     |

### Baseline summary

- 2.3 Based on the calculation in Table 1, the baseline for site-wide energy demand is **1,841,807 kWh/year**.

### Best practice energy efficiency measures

- 2.4 As a first energy efficiency measure, the proposed dwellings will incorporate sufficient insulation in the building envelope (walls, roofs, floors and glazing) to achieve average U-values considerably better than the limiting standards demanded by Part L1a of 2013 Building Regulations.
- 2.5 Table 2 overleaf illustrates the proposed U-values and the limiting area-weighted values set by Part L1a of 2013 Building Regulations.

**Table 2: Insulation Enhancement Proposals**

| <b>Thermal Element</b> | <b>Maximum Area-Weighted U-value (W/m<sup>2</sup>K) Under 2013 Building Regulations</b> | <b>Proposed U-value (W/m<sup>2</sup>K) Required to Meet 2013 Building Regulations Baseline</b> | <b>% Improvement on 2013 Allowable U-Value Standard</b> |
|------------------------|-----------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------|---------------------------------------------------------|
| Main external walls    | 0.30                                                                                    | 0.24                                                                                           | 20.00                                                   |
| Roof (joists)          | 0.20                                                                                    | 0.11                                                                                           | 50.00                                                   |
| Ground floor           | 0.25                                                                                    | 0.15                                                                                           | 40.00                                                   |
| Windows                | 2.00                                                                                    | 1.30                                                                                           | 35.00                                                   |

- 2.6 The Client intends to meet the U-value performance standards detailed in Table 2 through the following construction specification for the main thermal elements (Table 3):

**Table 3: Fabric Enhancement Construction Specification**

| <b>Construction Element</b>  | <b>Delivered U-Value</b> | <b>Insulation Specification</b>                                                                                                                                                                                                                                              |
|------------------------------|--------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Main external walls (houses) | 0.24                     | 302.5mm overall structural width comprising outer leaf of 102.5mm, 100mm cavity fully filled with blown mineral fibre insulation (thermal conductivity of 0.034 W/m <sup>2</sup> K), and inner leaf of 100mm aerated block.                                                  |
| Party walls                  | 0.00                     | Fully filled and sealed.                                                                                                                                                                                                                                                     |
| Roof (joists)                | 0.11                     | One layer of 100mm mineral wool insulation (thermal conductivity of 0.044 W/m <sup>2</sup> K) laid between ceiling joists and one layer of 300mm mineral wool insulation (thermal conductivity of 0.044 W/m <sup>2</sup> K) laid over to provide a total thickness of 400mm. |
| Ground floor                 | 0.15                     | Beam and block construction to include 100mm insulation (thermal conductivity maximum of 0.022 W/m <sup>2</sup> K) with 75mm screed topping.                                                                                                                                 |
| Windows                      | 1.30                     | Double-glazed windows with low 'e' soft coat glazing to specialist BFRC approved manufacturers design.                                                                                                                                                                       |

- 2.7 All insulating materials specified at the Hook Lane development will have an Ozone Depleting Potential of Zero and a Global Warming Potential of less than 5. It is intended that the development will utilise low Volatile Organic Compounds. These are usually solvents that have the capacity to rapidly evaporate. Once airborne they cause chemical or photochemical reactions in the atmosphere leading to the formation of smog containing, amongst other things, ground level ozone and can produce a number of physical problems such as eye and skin irritation, lung and breathing problems, headaches, nausea and muscle weakness. Preference will also be given to the specification of inert materials as they are non-toxic and easily re-used or recycled.
- 2.8 The performance standards and fabric measures detailed in Tables 2 and 3 will result in a reduced space heating requirement for the dwellings. The dwellings will also benefit from advanced heating controls through the installation of programmers, room thermostats, thermostatic radiator valves and dual zone controls. As such, it will be possible for future occupants to minimise the emissions associated with the heating operation of their home. The specified boiler for all dwellings will have a SEDBUK (2009) energy efficiency of at least 88.5% and are Class 5 for NO<sub>x</sub> emissions.
- 2.9 Air tightness standards will be improved by the Client adopting a mixture of Aircrete Product Association (APA) and Accredited Construction Details for non-repeating thermal bridges. These details incorporate an improvement over Building Regulations (2013) requirements by reducing air leakage loss and convective bypass of insulation. The Client will reduce each dwelling's design air permeability from 10 m<sup>3</sup>/hm<sup>2</sup> to not more than 5.01 m<sup>3</sup>/hm<sup>2</sup> to further reduce space heating requirements. It is not proposed to provide any mechanical cooling to the proposed dwellings. Instead it is the intention of the Client 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. Ventilation to the dwellings will be facilitated via the installation of highly efficient intermittent extract fans (System 1). In addition, the development will adopt a range of passive ventilation measures. Openable windows will help facilitate cross-ventilation, convective-ventilation and night purging.
- 2.10 All of the internal lighting throughout the 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.

**Summary of outcomes after energy efficiency measures**

- 2.11 Table 4 outlines the outcomes for carbon dioxide emissions and energy demand after the Applicant's adoption of the energy efficiency measures described in paragraphs 2.4 to 2.10. Emissions for each house type have been calculated by multiplying the Dwelling Emission Rate (kgCO<sub>2</sub>/m<sup>2</sup>/year) by its floor area, before these were aggregated according to the number of dwellings pertaining to each type and the overall site.

**Outcome after best practice energy efficiency measures**

- 2.12 Following the adoption of the measures above, site-wide energy demand will be reduced from the baseline case of **1,841,807 kWh/year** to **1,771,092 kWh/year**, as set out in Table 4 below.

**Table 4: Carbon dioxide emissions and energy demand calculation for Hook Lane – after energy efficiency measures**

| Dwelling Type  | Baseline Carbon<br>Dioxide Emissions<br>(KgCO <sub>2</sub> /yr) | Energy<br>Demand<br>(kWh/yr) | Number of<br>Dwellings | Total Energy Demand<br>(kWh/yr) |
|----------------|-----------------------------------------------------------------|------------------------------|------------------------|---------------------------------|
| <b>Private</b> |                                                                 |                              |                        |                                 |
| Slater         | 1,186                                                           | 4,578                        | 7                      | 32,046                          |
| Cooper         | 1,188                                                           | 4,586                        | 22                     | 100,885                         |
| Woodcarver     | 1,287                                                           | 4,968                        | 8                      | 39,743                          |
| Coiner         | 1,326                                                           | 5,118                        | 25                     | 127,959                         |
| Tailor         | 1,217                                                           | 4,698                        | 8                      | 37,581                          |
| Thespian       | 1,579                                                           | 6,095                        | 6                      | 36,570                          |
| Quilter        | 1,516                                                           | 5,852                        | 17                     | 99,480                          |
| Tanner         | 1,542                                                           | 5,952                        | 4                      | 23,808                          |
| Coppersmith    | 1,573                                                           | 6,072                        | 12                     | 72,861                          |
| Blemmere       | 1,573                                                           | 6,072                        | 4                      | 24,287                          |
| Framer         | 1,591                                                           | 6,141                        | 17                     | 104,401                         |
| Mason          | 1,601                                                           | 6,180                        | 17                     | 105,058                         |
| Sculptor       | 1,761                                                           | 6,797                        | 5                      | 33,987                          |
| Bowyer         | 1,899                                                           | 7,330                        | 15                     | 109,952                         |

|                             |       |       |            |                  |
|-----------------------------|-------|-------|------------|------------------|
| Goldsmith                   | 2,054 | 7,928 | 14         | 110,998          |
| Arkwright                   | 2,106 | 8,129 | 23         | 186,971          |
| Weaver                      | 2,265 | 8,743 | 6          | 52,457           |
| <b>Sub-total</b>            |       |       | <b>210</b> | <b>1,299,044</b> |
| <b>Affordable</b>           |       |       |            |                  |
| Souter                      | 1,004 | 3,875 | 18         | 69,758           |
| Glover                      | 1,140 | 4,400 | 18         | 79,207           |
| Baker                       | 1,448 | 5,589 | 16         | 89,428           |
| Romsey                      | 1,683 | 6,496 | 12         | 77,957           |
| Ploughwright                | 1,535 | 5,925 | 5          | 29,626           |
| Tilman                      | 1,519 | 5,863 | 15         | 87,950           |
| Cartographer                | 1,646 | 6,354 | 6          | 38,121           |
| <b>Sub-total</b>            |       |       | <b>90</b>  | <b>472,047</b>   |
| <b>TOTAL</b>                |       |       | <b>300</b> | <b>1,771,092</b> |
| <b>Average per dwelling</b> |       |       |            | <b>5,904</b>     |

- 2.13 The reduction against the baseline is **70,715 kWh/year**, or **3.84%** in percentage terms. In order to now satisfy the requirement to deliver 10% of energy demand from a feasible renewable energy or low carbon technology, the Applicant must contribute generation of at least **177,109 kWh/year**.

#### **Feasibility of renewable energy or low carbon technologies**

- 2.14 The technologies to be evaluated in this Statement are as follows:

- District Heating / CHP
- Biomass
- Heat pumps (ground source and air source)
- Hydroelectric power
- Wind energy
- Solar thermal panels
- Solar photovoltaic panels

2.15 The Applicant has conducted a detailed review of the feasibility of installing Combined Heat and Power infrastructure (CHP) to serve the Hook Lane development. 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. 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 built out in a single phase, or a very 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 phased scheme such as this with no industrial demands, heat demand would be moderate and not continuous, especially during the working day, leading to an over-generation and subsequent dumping of heat.
- **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 one of the proposed areas of public open space, but the installation of such infrastructure would be in conflict with the Applicant's objective to deliver a vibrant and ecologically prosperous development with land uses suitable for children and young families. The noise emissions generated from plant infrastructure would also be high.
- **Minimised 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, which reduces the suitability of any district heating scheme.
- **Installed costs** – the installed cost of any CHP / district heating network benefit from economies of scale. However, pipe run costs remain approximately £1,000 per metre, and

total costs for CHP infrastructure across the site – predominantly from the plant room, CHP engine and pipe runs – would likely extend beyond £8 million for a scheme of this scale.

- **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 development.

2.16 Biomass community heating is an alternative to conventional fossil fuel heating but, as per the reasons used against the installation of gas-fuelled CHP or district heating, should be discounted as an option at Hook Lane 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 majority of proposed dwelling types, especially the two bedroom houses. The management of fuel deliveries and ash dispersal is also complex, necessitating a dedicated operative as opposed to residents of the future dwellings at Hook Lane. 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 and ASHPs)**

2.17 ASHPs are a potential technology that could be deployed but have not been considered by the Applicant for implementation across the site due to the potential for both noise and visually related impacts on the residents and surroundings. There is insufficient land available for sufficient boreholes to be drilled for GSHPs to represent a viable heating option for the apartments.

#### **Hydroelectric power**

2.18 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 Hook Lane development to facilitate a hydroelectric power installation.

### **Wind Turbines**

- 2.19 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 Hook Lane development is 4.6m/s at 10m AOD and is below the level required to generate significant energy demand 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 neighbours and the rural surrounds. Furthermore, this technology could only generate significant reductions in energy demand for a small proportion of the 300 dwellings associated with the development.

### **Solar thermal and photovoltaic panels**

- 2.20 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 some cases. This is because the smaller dwelling types, such as the various two bedroom houses, have very little space to accommodate a large hot water cylinder incorporating dedicated solar storage. In contrast, there are few constraints on the capacity for solar photovoltaic panels to deliver reductions in energy demand. For nearly all of the dwellings on the site, roof-space is available at no worse than a west-east orientation and there is sufficient roof-space available to accommodate up to 4-6 panels.

### **Impacts of strategy**

- 2.21 Further SAP calculations have been undertaken which have verified that a total of 160 kWp of solar photovoltaic output is necessary for the Hook Lane development to deliver site-wide reductions in energy demand of at least 10%. This is equivalent to approximately 640 panels across the site. At this stage, the Applicant has not determined the location of panels, however, when consulting with their solar engineer, preference will be given to maximising installations on roof-space of optimal,

southerly orientation. Examples of the impact of providing installations of 0.75 kWp (2 panels) to plots 92 (Type Baker) and 107 (Type Mason) are provided in the Appendix to this Statement. Across the site, 160 kWp of solar photovoltaic output will reduce site-wide energy demand by **178,000 kWh/year**. As Table 4 depicts, in combination with the reductions in energy demand of **70,715 kWh/year** secured via best practice energy efficiency measures, the Applicant's proposed strategy is projected to deliver overall reductions of **248,715 kWh/year**, which are equal to a **13.50%** decline compared to baseline energy demand of 1,841,807 kWh/year. In addition, compared to site-wide energy demand after energy efficiency measures, which was 1,771,092 kWh/year, the contribution from renewable energy of 178,000 kWh/year constitutes **10.05%**.

**Table 4: Energy Demand Reduction from Energy Efficiency Measures and Solar PV Installations – Hook Lane**

|                                                   | Energy Demand (kWh/year) |
|---------------------------------------------------|--------------------------|
| Baseline                                          | 1,841,807                |
| Reduction from energy efficiency measures         | (70,715)                 |
| Reduction from 160 kWp solar PV output            | (178,000)                |
| <b>Total reduction</b>                            | <b>(248,715)</b>         |
| <b>Energy demand after reductions</b>             | <b>1,593,092</b>         |
| <b>Overall percentage reduction from baseline</b> | <b>13.50</b>             |

### 3. Conclusion

- 3.1 This Statement has set out the Applicant's energy strategy which has been developed to comply with the requirements of Condition 26 and Policy ECC SP2 (Energy and Climate Change Mitigation) of Arun District Council's Local Plan (2018). These required the Applicant to deliver a 10% reduction in site-wide energy demand compared to the corresponding standard determined by Part L1a of Building Regulations, having accounted for any reductions delivered via energy efficiency measures.

- 3.2 The Applicant's priority was to minimise energy consumption at the point of demand through best practice fabric and energy efficiency measures, thus ensuring that reductions in emissions will persist over the lifetime of the development. The Applicant's strategy will be delivered through the installation of highly efficient fabric, ventilation and heating systems, together with the benefits of passive solar gains and an air-tight build, all features which will help to lower the fuel bills of future occupants. In addition, 160 kWp of solar photovoltaic output will be installed to dwellings with optimal, south-facing roof-space. Overall, the Applicant's strategy of best practice energy efficiency measures and strategically located renewable energy installations will reduce energy demand by **10.05%** (after energy efficiency measures) across the residential component of the Hook Lane development. Factoring in reductions from energy efficiency measures as well, the proposals deliver a 13.50% reduction in energy demand against the regulatory baseline.

## **Appendix**

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

Type Baker (Plot 92) with 0.75 kWp of solar PV output

Type Mason (Plot 107) with 0.75 kWp of solar PV output

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



|                                    |                                                                         |               |       |                |            |
|------------------------------------|-------------------------------------------------------------------------|---------------|-------|----------------|------------|
| Property Reference                 | SECH00092                                                               |               |       | Issued on Date | 16/03/2022 |
| Assessment Reference               | 001                                                                     | Prop Type Ref | BA    |                |            |
| Property                           | Plot 92, Pagham, Bognor Regis, West Sussex, PO21                        |               |       |                |            |
| SAP Rating                         | 87 B                                                                    | DEI           | 14.47 | TSL            | 18.80      |
| Environmental                      | 89 B                                                                    | % DER-TER     | 23.04 |                |            |
| CO <sub>2</sub> Emissions (t/year) | 0.84                                                                    | DEE           | 48.49 | TTEE           | 55.03      |
| General Requirements Compliance    | Pass                                                                    | % DEE-CTEE    | 11.88 |                |            |
| Assessor Details                   | Mr. Stephen Smith, Southern Energy Consultants Limited, Tel: [REDACTED] |               |       | Assessor ID    | d168-0001  |
| Client                             | Belliway 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

Semi-Detached House, total floor area 81 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) 18.80 kgCO<sub>2</sub>/m<sup>2</sup>  
Dwelling Carbon Dioxide Emission Rate (DER) 14.47 kgCO<sub>2</sub>/m<sup>2</sup> OK

#### 1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE) 55.0 kWh/m<sup>2</sup>/yr  
Dwelling Fabric Energy Efficiency (DFEE) 48.5 kWh/m<sup>2</sup>/yr OK

#### 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          | 0.11 (max. 0.20) | 0.12 (max. 0.35) | OK |
| Openings      | 1.32 (max. 2.00) | 1.50 (max. 3.30) | OK |

#### 2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

#### 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

Not applicable

#### 9 Summertime temperature

Overheating risk (Thames Valley): Medium OK

#### Based on:

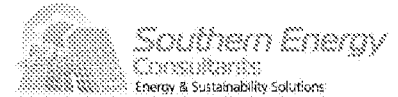
Overshading: Average  
Windows facing North East: 0.78 m<sup>2</sup>, No overhang  
Windows facing South East: 5.70 m<sup>2</sup>, No overhang  
Windows facing South West: 0.78 m<sup>2</sup>, No overhang  
Windows facing North West: 8.29 m<sup>2</sup>, No overhang  
Air change rate: 4.00 ach  
Blinds/curtains: None

#### 10 Key features

Party wall U-value 0.00 W/m<sup>2</sup>K  
Roof U-value 0.11 W/m<sup>2</sup>K  
Roof U-value 0.12 W/m<sup>2</sup>K  
Floor U-value 0.11 W/m<sup>2</sup>K  
Photovoltaic array 0.75 kW

# 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                                           | 40.6900 (1b)              | x 2.4000 (2b)                   | = 97.6560 (1b) - (3b)       |
| First floor                                            | 40.6000 (1c)              | x 2.6500 (2c)                   | = 107.5900 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 81.2900                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 205.2460 (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                                               |                 |                      |                             | 4 * 10 =        | 40.0000 (7a) |
| Number of passive vents                                                   |                 |                      |                             | 0 * 10 =        | 0.0000 (7b)  |
| Number of flueless gas fires                                              |                 |                      |                             | 0 * 40 =        | 0.0000 (7c)  |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = |                 |                      |                             | 40.0000 / (5) = | 0.1949 (8)   |
| Pressure test                                                             |                 |                      |                             | Yes             |              |
| Measured/design AP50                                                      |                 |                      |                             | 5.0000          |              |
| Infiltration rate                                                         |                 |                      |                             | 0.4449 (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) =        | 0.3782 (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 | 0.4821 | 0.4727 | 0.4632 | 0.4160 | 0.4065 | 0.3592 | 0.3592 | 0.3498 | 0.3782 | 0.4065 | 0.4254 | 0.4443 (22b) |
| Effective ac    | 0.6162 | 0.6117 | 0.6073 | 0.5865 | 0.5826 | 0.5645 | 0.5645 | 0.5612 | 0.5715 | 0.5826 | 0.5905 | 0.5987 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                      | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K   |
|--------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|-----------------|
| Opening Type 2 (Uw = 1.30)                                   |                         |                            | 15.5500                   | 1.2357                        | 19.2158      |                                | (27)            |
| Opening Type 3                                               |                         |                            | 2.1200                    | 1.5000                        | 3.1800       |                                | (26a)           |
| Heat Loss Floor 1                                            |                         |                            | 40.6900                   | 0.1100                        | 4.4759       | 75.0000                        | 3051.7500 (28a) |
| Brick Faced                                                  | 93.9300                 | 17.6700                    | 76.2600                   | 0.2400                        | 18.3024      | 60.0000                        | 4575.6000 (29a) |
| Plane Roof                                                   | 41.0600                 |                            | 41.0600                   | 0.1100                        | 4.5166       | 9.0000                         | 369.5400 (30)   |
| Flat Roof Kitchen/Diner                                      | 2.9200                  |                            | 2.9200                    | 0.1200                        | 0.3504       | 0.0000                         | 0.0000 (30)     |
| Total net area of external elements Aum (A, m <sup>2</sup> ) |                         |                            | 178.6000                  |                               |              |                                | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                          |                         |                            | (26)...(30) + (32) =      | 50.0411                       |              |                                | (33)            |
| Party Wall 1                                                 |                         |                            | 41.3500                   | 0.0000                        | 0.0000       | 45.0000                        | 1860.7500 (32)  |
| Internal Wall 2                                              |                         |                            | 163.5200                  |                               |              | 9.0000                         | 1471.6800 (32c) |
| Internal Floor 1                                             |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32d)  |
| Internal Ceiling 1                                           |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32e)  |

Heat capacity Cm = Sum(A x k)  
Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K  
Thermal bridges (Sum(L x Psi) calculated using Appendix K)  
Total fabric heat loss

|                                                                     |                |                |                |                |                |                |                |                |                |                |                |                     |
|---------------------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                |                |                |                |                |                |                |                |                |                     |
| (38)m                                                               | Jan<br>41.7382 | Feb<br>41.4325 | Mar<br>41.1328 | Apr<br>39.7254 | May<br>39.4621 | Jun<br>38.2362 | Jul<br>38.2362 | Aug<br>38.0092 | Sep<br>38.7084 | Oct<br>39.4621 | Nov<br>39.9948 | Dec<br>40.5517 (38) |
| Heat transfer coeff                                                 | 104.4008       | 104.0951       | 103.7954       | 102.3880       | 102.1247       | 100.8988       | 100.8988       | 100.6718       | 101.3710       | 102.1247       | 102.6574       | 103.2143 (39)       |
| Average = Sum(39)m / 12 =                                           |                |                |                |                |                |                |                |                |                |                |                | 102.3867 (39)       |

|               |               |               |               |               |               |               |               |               |               |               |               |                    |
|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| HLP           | Jan<br>1.2843 | Feb<br>1.2805 | Mar<br>1.2769 | Apr<br>1.2595 | May<br>1.2563 | Jun<br>1.2412 | Jul<br>1.2412 | Aug<br>1.2384 | Sep<br>1.2470 | Oct<br>1.2563 | Nov<br>1.2629 | Dec<br>1.2697 (40) |
| HLP (average) |               |               |               |               |               |               |               |               |               |               |               | 1.2595 (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                        |                 |                |                |                |                |                |                |                |                |                    |                | 2.4869 (42)          |
| Average daily hot water use (litres/day) |                 |                |                |                |                |                |                |                |                |                    |                | 93.2634 (43)         |
| Daily hot water use                      | Jan<br>102.5898 | Feb<br>98.8593 | Mar<br>95.1287 | Apr<br>91.3982 | May<br>87.6676 | Jun<br>83.9371 | Jul<br>83.9371 | Aug<br>87.6676 | Sep<br>91.3982 | Oct<br>95.1287     | Nov<br>98.8593 | Dec<br>102.5898 (44) |
| Energy conte                             | 152.1377        | 133.0606       | 137.3066       | 119.7072       | 114.8619       | 99.1171        | 91.8466        | 105.3953       | 106.6541       | 124.2950           | 135.6777       | 147.3372 (45)        |
| Energy content (annual)                  |                 |                |                |                |                |                |                |                |                | Total = Sum(45)m = |                | 1467.3971 (45)       |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

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

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Distribution loss (46)m = 0.15 x (45)m                          | 22.8207  | 19.9591  | 20.5960  | 17.9561  | 17.2293  | 14.8676  | 13.7770  | 15.8093  | 15.9981  | 18.6443  | 20.3517  | 22.1006 (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                    | 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                                                      | 14.1217  | 12.7410  | 14.0700  | 13.5754  | 13.9982  | 13.5125  | 13.9416  | 13.9783  | 13.5468  | 14.0403  | 13.6347  | 14.1102 (61)  |
| Total heat required for water heating calculated for each month | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474 (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                                                 | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474 (64) |
| Heat gains from water heating, kWh/month                        | 54.1162  | 47.4279  | 49.1720  | 43.1965  | 41.6912  | 36.3346  | 34.0244  | 38.5385  | 38.8492  | 44.8382  | 48.5215  | 52.5172 (65)  |
| Solar input (sum of months) = Sum(63)m = 0.0000 (63)            |          |          |          |          |          |          |          |          |          |          |          |               |
| Total per year (kWh/year) = Sum(64)m = 1632.6678 (64)           |          |          |          |          |          |          |          |          |          |          |          |               |

#### 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                                                                               | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 20.0461  | 17.8048  | 14.4798  | 10.9622  | 8.1943   | 6.9180   | 7.4752   | 9.7165   | 13.0415  | 16.5591  | 19.3269  | 20.6033 (67)  |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 222.1155 | 224.4203 | 218.6122 | 206.2472 | 190.6387 | 175.9689 | 166.1686 | 163.8637 | 169.6719 | 182.0368 | 197.6454 | 212.3151 (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344 (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)                                 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 (71) |
| Water heating gains (Table 5)                                                       | 72.7368  | 70.5772  | 66.0913  | 59.9951  | 56.0365  | 50.4647  | 45.7317  | 51.7991  | 53.9572  | 60.2664  | 67.3910  | 70.5876 (72)  |
| Total internal gains                                                                | 378.2017 | 376.1056 | 362.4866 | 340.5078 | 318.1728 | 296.6548 | 282.6787 | 288.6825 | 299.9738 | 322.1656 | 347.6665 | 366.8092 (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   |          |          |          |          | 0.7800     | 11.2829                        | 0.4500                            | 0.0000                             | 0.7700                       | 3.0494 (75)  |          |               |
| Southeast   |          |          |          |          | 5.7000     | 36.7938                        | 0.4500                            | 0.0000                             | 0.7700                       | 72.6697 (77) |          |               |
| Southwest   |          |          |          |          | 0.7800     | 36.7938                        | 0.4500                            | 0.0000                             | 0.7700                       | 9.9443 (79)  |          |               |
| Northwest   |          |          |          |          | 8.2900     | 11.2829                        | 0.4500                            | 0.0000                             | 0.7700                       | 32.4101 (81) |          |               |
|             |          |          |          |          |            |                                |                                   |                                    |                              |              |          |               |
| Solar gains | 118.0734 | 212.9010 | 322.5855 | 452.1376 | 554.2952   | 571.3404                       | 542.0716                          | 462.6387                           | 366.9423                     | 243.7362     | 143.5697 | 99.6583 (83)  |
| Total gains | 496.2751 | 589.0065 | 685.0720 | 792.6453 | 872.4680   | 867.9952                       | 824.7503                          | 751.3212                           | 666.9160                     | 565.9018     | 491.2362 | 466.4676 (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                                                                         | 34.0767 | 34.1768 | 34.2754 | 34.7466 | 34.8362 | 35.2594 | 35.2594 | 35.3389 | 35.0952 | 34.8362 | 34.6554 | 34.4684      |
| alpha                                                                       | 3.2718  | 3.2785  | 3.2850  | 3.3164  | 3.3224  | 3.3506  | 3.3506  | 3.3559  | 3.3397  | 3.3224  | 3.3104  | 3.2979       |
| util living area                                                            | 0.9882  | 0.9787  | 0.9575  | 0.9042  | 0.8001  | 0.6463  | 0.5048  | 0.5633  | 0.7875  | 0.9383  | 0.9806  | 0.9903 (86)  |
| MIT                                                                         | 19.0226 | 19.2634 | 19.6576 | 20.1708 | 20.6001 | 20.8648 | 20.9560 | 20.9364 | 20.7225 | 20.1560 | 19.5004 | 18.9854 (87) |
| Th 2                                                                        | 19.8532 | 19.8561 | 19.8590 | 19.8727 | 19.8752 | 19.8872 | 19.8872 | 19.8894 | 19.8826 | 19.8752 | 19.8700 | 19.8646 (88) |
| util rest of house                                                          | 0.9855  | 0.9739  | 0.9475  | 0.8810  | 0.7514  | 0.5619  | 0.3906  | 0.4474  | 0.7177  | 0.9185  | 0.9754  | 0.9881 (89)  |
| MIT 2                                                                       | 17.2307 | 17.5815 | 18.1514 | 18.8839 | 19.4580 | 19.7803 | 19.8648 | 19.8540 | 19.6316 | 18.8804 | 17.9372 | 17.1834 (90) |
| Living area fraction                                                        | 17.6204 | 17.9473 | 18.4790 | 19.1638 | 19.7064 | 20.0162 | 20.1022 | 20.0894 | 19.8689 | 19.1578 | 18.2772 | 17.5753 (92) |
| MIT                                                                         | 17.6204 | 17.9473 | 18.4790 | 19.1638 | 19.7064 | 20.0162 | 20.1022 | 20.0894 | 19.8689 | 19.1578 | 18.2772 | 17.5753 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |         |         | -0.1500      |
| adjusted MIT                                                                | 17.4704 | 17.7973 | 18.3290 | 19.0138 | 19.5564 | 19.8662 | 19.9522 | 19.9394 | 19.7189 | 19.0078 | 18.1272 | 17.4253 (93) |

#### 8. Space heating requirement

|                      |           |           |           |           |          |          |          |          |          |          |           |                |
|----------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------|
| Utilisation          | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec            |
| Useful gains         | 484.8234  | 566.1390  | 636.5440  | 680.7209  | 641.6649 | 486.2117 | 327.9491 | 340.3770 | 470.5745 | 508.0786 | 473.2070  | 457.4796 (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     | 1375.0008 | 1342.5469 | 1227.7921 | 1035.5323 | 802.3288 | 531.3489 | 338.2294 | 356.3180 | 569.5926 | 858.6428 | 1132.0250 | 1365.0402 (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    | 662.2920  | 521.7461  | 439.8886  | 255.4642  | 119.5339 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 260.8198 | 474.3490  | 675.2251 (98)  |
| Space heating        |           |           |           |           |          |          |          |          |          |          |           | 3409.3187 (98) |
| Space heating per m2 |           |           |           |           |          |          |          |          |          |          |           | 41.9402 (99)   |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

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

8c. Space cooling requirement

Not applicable

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                                             |          |          |          |          |          |          |          |          |          |          |          |           | 3767.2030 | (211) |
| Jan                                                                   | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec      |           |           |       |
| Space heating requirement                                             | 662.2920 | 521.7461 | 439.8886 | 255.4642 | 119.5339 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 260.8198 | 474.3490 | 675.2251  | (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)                              | 731.8143 | 576.5151 | 486.0647 | 282.2809 | 132.0817 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 288.1987 | 524.1425 | 746.1051  | (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                                             | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474  | (64)      |       |
| Efficiency of water heater (217)m                                     | 89.8392  | 89.7812  | 89.6586  | 89.3768  | 88.8112  | 87.3000  | 87.3000  | 87.3000  | 87.3000  | 89.3647  | 89.7127  | 89.8644   | (217)     |       |
| Fuel for water heating, kWh/month                                     | 185.0633 | 162.3965 | 168.8368 | 149.1244 | 145.0945 | 129.0144 | 121.1777 | 136.7395 | 137.6871 | 154.7986 | 166.4340 | 179.6567  | (219)     |       |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |          |          | 1836.0236 | (219)     |       |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |          |          |           |           |       |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |          |          | 3767.2030 | (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)                   |          |          |          |          |          |          |          |          |          |          |          | 354.0209  | (232)     |       |
| Energy saving/generation technologies (Appendices M,N and Q)          |          |          |          |          |          |          |          |          |          |          |          |           |           |       |
| PV Unit 0 (0.80 * 0.75 * 1029 * 0.80) =                               |          |          |          |          |          |          |          |          |          |          |          | -494.0096 | (233)     |       |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |          |          | 5538.2379 | (238)     |       |

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

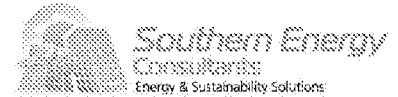
|                                             | Energy<br>kWh/year | Emission factor<br>kg CO2/kWh | Emissions<br>kg CO2/year |       |
|---------------------------------------------|--------------------|-------------------------------|--------------------------|-------|
| Space heating - main system 1               | 3767.2030          | 0.2160                        | 813.7158                 | (261) |
| Space heating - secondary                   | 0.0000             | 0.0000                        | 0.0000                   | (263) |
| Water heating (other fuel)                  | 1836.0236          | 0.2160                        | 396.5811                 | (264) |
| Space and water heating                     |                    |                               | 1210.2969                | (265) |
| Pumps and fans                              | 75.0000            | 0.5190                        | 38.9250                  | (267) |
| Energy for lighting                         | 354.0209           | 0.5190                        | 183.7368                 | (268) |
| Energy saving/generation technologies       |                    |                               |                          |       |
| PV Unit                                     | -494.0096          | 0.5190                        | -256.3910                | (269) |
| Total CO2, kg/year                          |                    |                               | 1176.5678                | (272) |
| Dwelling Carbon Dioxide Emission Rate (DER) |                    |                               | 14.4700                  | (273) |

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

|                                                                                 |  |     |         |     |
|---------------------------------------------------------------------------------|--|-----|---------|-----|
| DER                                                                             |  |     | 14.4700 | ZC1 |
| Total Floor Area                                                                |  | TFA | 81.2900 |     |
| Assumed number of occupants                                                     |  | N   | 2.4869  |     |
| CO2 emission factor in Table 12 for electricity displaced from grid             |  | EF  | 0.5190  |     |
| CO2 emissions from appliances, equation (L14)                                   |  |     | 16.1915 | ZC2 |
| CO2 emissions from cooking, equation (L16)                                      |  |     | 2.1981  | ZC3 |
| Total CO2 emissions                                                             |  |     | 32.8597 | 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                                                               |  |     | 32.8597 | 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                                           | 40.6900 (1b)              | x 2.4000 (2b)                   | = 97.6560 (1b) - (3b)       |
| First floor                                            | 40.6000 (1c)              | x 2.6500 (2c)                   | = 107.5900 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 81.2900                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 205.2460 (5)              |

#### 2. Ventilation rate

|                                                                         | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|-------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                      | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                    | 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)       |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) |                 |                      |       |                             | 30.0000 / (5) = 0.1462 (8) |
| Pressure test                                                           |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                    |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                       |                 |                      |       |                             | 0.3962 (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) =        | 0.3367 (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 | 0.4293 | 0.4209 | 0.4125 | 0.3704 | 0.3620 | 0.3199 | 0.3199 | 0.3115 | 0.3367 | 0.3620 | 0.3788 | 0.3957 (22b) |
| Effective ac    | 0.5922 | 0.5886 | 0.5851 | 0.5686 | 0.5655 | 0.5512 | 0.5512 | 0.5485 | 0.5567 | 0.5655 | 0.5718 | 0.5783 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                     | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K |
|-------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|---------------|
| TER Semi-glazed door                                        |                         |                            | 2.1200                    | 1.2000                        | 2.5440       |                                | (26a)         |
| TER Opening Type (Uw = 1.40)                                |                         |                            | 15.5500                   | 1.3258                        | 20.6155      |                                | (27)          |
| Heat Loss Floor 1                                           |                         |                            | 40.6900                   | 0.1300                        | 5.2897       |                                | (28a)         |
| Brick Faced                                                 | 93.9300                 | 17.6700                    | 76.2600                   | 0.1800                        | 13.7268      |                                | (29a)         |
| Plane Roof                                                  | 41.0600                 |                            | 41.0600                   | 0.1300                        | 5.3378       |                                | (30)          |
| Flat Roof Kitchen/Diner                                     | 2.9200                  |                            | 2.9200                    | 0.1300                        | 0.3796       |                                | (30)          |
| Total net area of external elements Aum(A, m <sup>2</sup> ) |                         |                            | 178.6000                  |                               |              |                                | (31)          |
| Fabric heat loss, W/K = Sum (A x U)                         |                         |                            | (26)...(30) + (32) =      |                               | 47.8934      |                                | (33)          |

|                                                                |                            |
|----------------------------------------------------------------|----------------------------|
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K | 250.0000 (35)              |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)     | 10.8427 (36)               |
| Total fabric heat loss                                         | (33) + (36) = 58.7361 (37) |

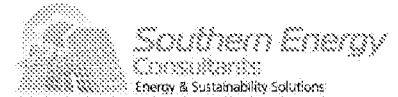
|                                                                     |         |         |         |         |         |         |         |         |         |         |         |              |
|---------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |         |         |         |         |         |         |         |         |         |         |         |              |
| (38)m                                                               | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
| Heat transfer coeff                                                 | 40.1083 | 39.8659 | 39.6283 | 38.5122 | 38.3034 | 37.3313 | 37.3313 | 37.1513 | 37.7058 | 38.3034 | 38.7258 | 39.1674 (38) |
| Average = Sum(39)m / 12 =                                           | 98.8444 | 98.6020 | 98.3644 | 97.2483 | 97.0395 | 96.0675 | 96.0675 | 95.8875 | 96.4419 | 97.0395 | 97.4619 | 97.9036 (39) |
|                                                                     |         |         |         |         |         |         |         |         |         |         |         | 97.2473 (39) |
| HLP                                                                 | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
| HLP (average)                                                       | 1.2159  | 1.2130  | 1.2100  | 1.1963  | 1.1937  | 1.1818  | 1.1818  | 1.1796  | 1.1864  | 1.1937  | 1.1989  | 1.2044 (40)  |
| Days in month                                                       |         |         |         |         |         |         |         |         |         |         |         | 1.1963 (40)  |
|                                                                     | 31      | 28      | 31      | 30      | 31      | 30      | 31      | 31      | 30      | 31      | 30      | 31 (41)      |

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

|                                          |                    |          |          |          |          |         |         |          |          |          |          |                |
|------------------------------------------|--------------------|----------|----------|----------|----------|---------|---------|----------|----------|----------|----------|----------------|
| Assumed occupancy                        |                    |          |          |          |          |         |         |          |          |          |          | 2.4869 (42)    |
| Average daily hot water use (litres/day) |                    |          |          |          |          |         |         |          |          |          |          | 93.2634 (43)   |
|                                          | Jan                | Feb      | Mar      | Apr      | May      | Jun     | Jul     | Aug      | Sep      | Oct      | Nov      | Dec            |
| Daily hot water use                      | 102.5898           | 98.8593  | 95.1287  | 91.3982  | 87.6676  | 83.9371 | 83.9371 | 87.6676  | 91.3982  | 95.1287  | 98.8593  | 102.5898 (44)  |
| Energy conte                             | 152.1377           | 133.0606 | 137.3066 | 119.7072 | 114.8619 | 99.1171 | 91.8466 | 105.3953 | 106.6541 | 124.2950 | 135.6777 | 147.3372 (45)  |
| Energy content (annual)                  | Total = Sum(45)m = |          |          |          |          |         |         |          |          |          |          | 1467.3971 (45) |
| Distribution loss (46)m = 0.15 x (45)m   | 22.8207            | 19.9591  | 20.5960  | 17.9561  | 17.2293  | 14.8676 | 13.7770 | 15.8093  | 15.9981  | 18.6443  | 20.3517  | 22.1006 (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)    |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF TARGET EMISSIONS 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| 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                                                      | 50.9589  | 45.5023  | 48.4765  | 45.0731  | 44.6745  | 41.3936  | 42.7734  | 44.6745  | 45.0731  | 48.4765  | 48.7525  | 50.9589 (61)  |
| Total heat required for water heating calculated for each month | 203.0966 | 178.5629 | 185.7832 | 164.7803 | 159.5364 | 140.5108 | 134.6200 | 150.0698 | 151.7271 | 172.7716 | 184.4302 | 198.2961 (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                                                 | 203.0966 | 178.5629 | 185.7832 | 164.7803 | 159.5364 | 140.5108 | 134.6200 | 150.0698 | 151.7271 | 172.7716 | 184.4302 | 198.2961 (64) |
| Heat gains from water heating, kWh/month                        | 63.3255  | 55.6182  | 57.7736  | 51.0709  | 49.3602  | 43.3049  | 41.2323  | 46.2126  | 46.7307  | 53.4472  | 57.3010  | 61.7294 (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                                                                               | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 20.0461  | 17.0048  | 14.4798  | 10.9622  | 8.1943   | 6.9180   | 7.4752   | 9.7165   | 13.0415  | 16.5591  | 19.3269  | 20.6033 (67)  |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 222.1155 | 224.4203 | 218.6122 | 206.2472 | 190.6387 | 175.9689 | 166.1686 | 163.8637 | 169.6719 | 182.0368 | 197.6454 | 212.3151 (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344 (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)                                 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 (71) |
| Water heating gains (Table 5)                                                       | 85.1149  | 82.7652  | 77.6527  | 70.9318  | 66.3444  | 60.1456  | 55.4198  | 62.1136  | 64.9038  | 71.8377  | 79.5847  | 82.9696 (72)  |
| Total internal gains                                                                | 390.5798 | 388.2936 | 374.0479 | 351.4445 | 328.4807 | 306.3358 | 292.3668 | 298.9971 | 310.9204 | 333.7369 | 359.8602 | 379.1912 (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   |          |          | 0.7800     | 11.2829                        |          | 0.6300                            |          | 0.7000                             |          | 0.7700                       |          | 2.6896 (75)   |
| Southeast   |          |          | 5.7000     | 36.7938                        |          | 0.6300                            |          | 0.7000                             |          | 0.7700                       |          | 64.0946 (77)  |
| Southwest   |          |          | 0.7800     | 36.7938                        |          | 0.6300                            |          | 0.7000                             |          | 0.7700                       |          | 8.7708 (79)   |
| Northwest   |          |          | 8.2900     | 11.2829                        |          | 0.6300                            |          | 0.7000                             |          | 0.7700                       |          | 28.5857 (81)  |
|             |          |          |            |                                |          |                                   |          |                                    |          |                              |          |               |
| Solar gains | 104.1408 | 187.7787 | 284.5204   | 398.7853                       | 488.8884 | 503.9222                          | 478.1071 | 408.0473                           | 323.6431 | 214.9753                     | 126.6285 | 87.8987 (83)  |
| Total gains | 494.7205 | 576.0722 | 658.5683   | 750.2298                       | 817.3691 | 810.2580                          | 770.4740 | 707.0444                           | 634.5635 | 548.7122                     | 486.4887 | 467.0899 (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                                                                         | 57.1114 | 57.2518 | 57.3901 | 58.0487 | 58.1736 | 58.7622 | 58.7622 | 58.8725 | 58.5341 | 58.1736 | 57.9215 | 57.6602      |
| alpha                                                                       | 4.8074  | 4.8168  | 4.8260  | 4.8699  | 4.8782  | 4.9175  | 4.9175  | 4.9248  | 4.9023  | 4.8782  | 4.8614  | 4.8440       |
| util living area                                                            | 0.9979  | 0.9952  | 0.9869  | 0.9564  | 0.8682  | 0.7003  | 0.5353  | 0.5994  | 0.8497  | 0.9760  | 0.9956  | 0.9984 (86)  |
| MIT                                                                         | 19.6791 | 19.8415 | 20.1128 | 20.4739 | 20.7790 | 20.9455 | 20.9882 | 20.9801 | 20.8551 | 20.4571 | 20.0033 | 19.6519 (87) |
| Th 2                                                                        | 19.9073 | 19.9096 | 19.9120 | 19.9230 | 19.9250 | 19.9346 | 19.9346 | 19.9364 | 19.9309 | 19.9250 | 19.9208 | 19.9165 (88) |
| util rest of house                                                          | 0.9971  | 0.9935  | 0.9822  | 0.9398  | 0.8199  | 0.6063  | 0.4125  | 0.4728  | 0.7768  | 0.9638  | 0.9937  | 0.9978 (89)  |
| MIT 2                                                                       | 18.1526 | 18.3912 | 18.7864 | 19.3073 | 19.7101 | 19.8989 | 19.9304 | 19.9283 | 19.8142 | 19.2937 | 18.6360 | 18.1193 (90) |
| Living area fraction                                                        | 18.4846 | 18.7066 | 19.0749 | 19.5610 | 19.9426 | 20.1265 | 20.1604 | 20.1571 | 20.0406 | 19.5467 | 18.9334 | 18.4526 (92) |
| MIT                                                                         | 18.4846 | 18.7066 | 19.0749 | 19.5610 | 19.9426 | 20.1265 | 20.1604 | 20.1571 | 20.0406 | 19.5467 | 18.9334 | 18.4526 (93) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |         |         | 0.0000       |
| adjusted MIT                                                                | 18.4846 | 18.7066 | 19.0749 | 19.5610 | 19.9426 | 20.1265 | 20.1604 | 20.1571 | 20.0406 | 19.5467 | 18.9334 | 18.4526 (93) |

#### 8. Space heating requirement

|                                  |           |           |           |           |          |          |          |          |          |              |           |                |
|----------------------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|--------------|-----------|----------------|
| Utilisation                      | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct          | Nov       | Dec            |
| Useful gains                     | 492.5754  | 570.7584  | 643.4829  | 699.7654  | 670.8712 | 505.9836 | 338.5070 | 353.7527 | 498.4622 | 525.6239     | 482.2278  | 465.5382 (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                 | 1402.0710 | 1361.3600 | 1236.9231 | 1036.7682 | 799.8546 | 530.9213 | 342.0428 | 360.2560 | 572.9221 | 868.1866     | 1153.3013 | 1395.3810 (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                | 676.6648  | 531.2843  | 441.5195  | 242.6420  | 95.9636  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 254.8667     | 483.1729  | 691.8030 (98)  |
| Space heating                    |           |           |           |           |          |          |          |          |          |              |           | 3417.9167 (98) |
| Space heating per m <sup>2</sup> |           |           |           |           |          |          |          |          |          | (98) / (4) = |           | 42.0460 (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

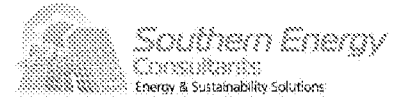
|                                                                       |          |          |          |          |          |          |          |          |          |          |          |           |                 |
|-----------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------------|
| 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                                             |          |          |          |          |          |          |          |          |          |          |          |           | 3659.4397 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec       |                 |
| Space heating requirement                                             | 676.6648 | 531.2843 | 441.5195 | 242.6420 | 95.9636  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 254.8667 | 483.1729 | 691.8030  | (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)                              | 724.4805 | 568.8269 | 472.7189 | 259.7880 | 102.7448 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 272.8765 | 517.3157 | 740.6884  | (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                                             | 203.0966 | 178.5629 | 185.7832 | 164.7803 | 159.5364 | 140.5108 | 134.6200 | 150.0698 | 151.7271 | 172.7716 | 184.4302 | 198.2961  | (64)            |
| Efficiency of water heater (217)m                                     | 87.8492  | 87.6275  | 87.1535  | 86.0239  | 83.8172  | 80.3000  | 80.3000  | 80.3000  | 80.3000  | 86.0284  | 87.3643  | 80.3000   | (216)           |
| Fuel for water heating, kWh/month                                     | 231.1878 | 203.7750 | 213.1678 | 191.5517 | 190.3384 | 174.9823 | 167.6463 | 186.8864 | 188.9503 | 200.8309 | 211.1047 | 225.5006  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |          |          | 2385.9225 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |          |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |          |          | 3659.4397 | (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)                   |          |          |          |          |          |          |          |          |          |          |          | 354.0209  | (232)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |          |          | 6474.3831 | (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                                                                     | 3659.4397          | 0.2160                        | 790.4390 (261)           |
| Space heating - secondary                                                                         | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)                                                                        | 2385.9225          | 0.2160                        | 515.3593 (264)           |
| Space and water heating                                                                           |                    |                               | 1305.7982 (265)          |
| Pumps and fans                                                                                    | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                                                                               | 354.0209           | 0.5190                        | 183.7368 (268)           |
| Total CO2, kg/m2/year                                                                             |                    |                               | 1528.4601 (272)          |
| Emissions per m2 for space and water heating                                                      |                    |                               | 16.0635 (272a)           |
| Fuel factor (mains gas)                                                                           |                    |                               | 1.0000                   |
| Emissions per m2 for lighting                                                                     |                    |                               | 2.2603 (272b)            |
| Emissions per m2 for pumps and fans                                                               |                    |                               | 0.4788 (272c)            |
| Target Carbon Dioxide Emission Rate (TER) = (16.0635 * 1.00) + 2.2603 + 0.4788, rounded to 2 d.p. |                    |                               | 18.8000 (273)            |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF FABRIC ENERGY EFFICIENCY 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                                           | 40.6900 (1b)              | x 2.4000 (2b)                   | = 97.6560 (1b) - (3b)       |
| First floor                                            | 40.6000 (1c)              | x 2.6500 (2c)                   | = 107.5900 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 81.2900                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 205.2460 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other                       | total | m <sup>3</sup> per hour    |
|---------------------------------------------------------------------------|-----------------|----------------------|-----------------------------|-------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0                           | =     | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 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) = 0.1462 (8) |
| Pressure test                                                             |                 |                      |                             |       | Yes                        |
| Measured/design AP50                                                      |                 |                      |                             |       | 5.0000                     |
| Infiltration rate                                                         |                 |                      |                             |       | 0.3962 (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) =        |       | 0.3367 (21)                |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.1000 | 5.0000 | 4.9000 | 4.4000 | 4.3000 | 3.8000 | 3.8000 | 3.7000 | 4.0000 | 4.3000 | 4.5000 | 4.7000 (22)  |
| Wind factor     | 1.2750 | 1.2500 | 1.2250 | 1.1000 | 1.0750 | 0.9500 | 0.9500 | 0.9250 | 1.0000 | 1.0750 | 1.1250 | 1.1750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac    | 0.4293 | 0.4209 | 0.4125 | 0.3704 | 0.3620 | 0.3199 | 0.3199 | 0.3115 | 0.3367 | 0.3620 | 0.3788 | 0.3957 (22b) |
|                 | 0.5922 | 0.5886 | 0.5851 | 0.5686 | 0.5655 | 0.5512 | 0.5512 | 0.5485 | 0.5567 | 0.5655 | 0.5718 | 0.5783 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                      | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K   |
|--------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|-----------------|
| Opening Type 2 (Uw = 1.30)                                   |                         |                            | 15.5500                   | 1.2357                        | 19.2158      |                                | (27)            |
| Opening Type 3                                               |                         |                            | 2.1200                    | 1.5000                        | 3.1800       |                                | (26a)           |
| Heat Loss Floor 1                                            |                         |                            | 40.6900                   | 0.1100                        | 4.4759       | 75.0000                        | 3051.7500 (28a) |
| Brick Faced                                                  | 93.9300                 | 17.6700                    | 76.2600                   | 0.2400                        | 18.3024      | 60.0000                        | 4575.6000 (29a) |
| Plane Roof                                                   | 41.0600                 |                            | 41.0600                   | 0.1100                        | 4.5166       | 9.0000                         | 369.5400 (30)   |
| Flat Roof Kitchen/Diner                                      | 2.9200                  |                            | 2.9200                    | 0.1200                        | 0.3504       | 0.0000                         | 0.0000 (30)     |
| Total net area of external elements Aum (A, m <sup>2</sup> ) |                         |                            | 178.6000                  |                               |              |                                | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                          |                         |                            |                           | (26)...(30) + (32) =          | 50.0411      |                                | (33)            |
| Party Wall 1                                                 |                         |                            | 41.3500                   | 0.0000                        | 0.0000       | 45.0000                        | 1860.7500 (32)  |
| Internal Wall 2                                              |                         |                            | 163.5200                  |                               |              | 9.0000                         | 1471.6800 (32c) |
| Internal Floor 1                                             |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32d)  |
| Internal Ceiling 1                                           |                         |                            | 41.0600                   |                               |              | 9.0000                         | 369.5400 (32e)  |

Heat capacity Cm = Sum(A x k)  
Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K  
Thermal bridges (Sum(L x Psi) calculated using Appendix K)  
Total fabric heat loss

|                                                                     |                |                |                |                |                |                |                |                |                |                |                |                     |
|---------------------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|
| (28)...(30) + (32) + (32a)...(32e) = 12437.9400 (34)                |                |                |                |                |                |                |                |                |                |                |                |                     |
| 153.0070 (35)                                                       |                |                |                |                |                |                |                |                |                |                |                |                     |
| 12.6215 (36)                                                        |                |                |                |                |                |                |                |                |                |                |                |                     |
| (33) + (36) = 62.6626 (37)                                          |                |                |                |                |                |                |                |                |                |                |                |                     |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                |                |                |                |                |                |                |                |                |                     |
| (38)m                                                               | Jan<br>40.1083 | Feb<br>39.8659 | Mar<br>39.6283 | Apr<br>38.5122 | May<br>38.3034 | Jun<br>37.3313 | Jul<br>37.3313 | Aug<br>37.1513 | Sep<br>37.7058 | Oct<br>38.3034 | Nov<br>38.7258 | Dec<br>39.1674 (38) |
| Heat transfer coeff                                                 | 102.7709       | 102.5285       | 102.2909       | 101.1748       | 100.9660       | 99.9939        | 99.9939        | 99.8139        | 100.3684       | 100.9660       | 101.3884       | 101.8300 (39)       |
| Average = Sum(39)m / 12 =                                           |                |                |                |                |                |                |                |                |                |                |                | 101.1738 (39)       |
| HLP                                                                 | Jan<br>1.2642  | Feb<br>1.2613  | Mar<br>1.2583  | Apr<br>1.2446  | May<br>1.2420  | Jun<br>1.2301  | Jul<br>1.2301  | Aug<br>1.2279  | Sep<br>1.2347  | Oct<br>1.2420  | Nov<br>1.2472  | Dec<br>1.2527 (40)  |
| HLP (average)                                                       |                |                |                |                |                |                |                |                |                |                |                | 1.2446 (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                        |          |          |          |          |          |         |         |          |          |                    |          | 2.4869 (42)    |
| Average daily hot water use (litres/day) |          |          |          |          |          |         |         |          |          |                    |          | 93.2634 (43)   |
| Jan                                      | Feb      | Mar      | Apr      | May      | Jun      | Jul     | Aug     | Sep      | Oct      | Nov                | Dec      |                |
| Daily hot water use                      | 102.5898 | 98.8593  | 95.1287  | 91.3982  | 87.6676  | 83.9371 | 83.9371 | 87.6676  | 91.3982  | 95.1287            | 98.8593  | 102.5898 (44)  |
| Energy conte                             | 152.1377 | 133.0606 | 137.3066 | 119.7072 | 114.8619 | 99.1171 | 91.8466 | 105.3953 | 106.6541 | 124.2950           | 135.6777 | 147.3372 (45)  |
| Energy content (annual)                  |          |          |          |          |          |         |         |          |          | Total = Sum(45)m = |          | 1467.3971 (45) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

### CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

|                                              |         |         |         |         |         |         |         |         |         |         |         |              |
|----------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Distribution loss (46)m = 0.15 x (45)m       | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000 (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 | 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)  |
| Primary 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 (59)  |
| Heat gains from water heating, kWh/month     | 32.3293 | 28.2754 | 29.1777 | 25.4378 | 24.4082 | 21.0624 | 19.5174 | 22.3965 | 22.6640 | 26.4127 | 28.8315 | 31.3092 (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                                                                               | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 20.0461  | 17.8048  | 14.4798  | 10.9622  | 8.1943   | 6.9180   | 7.4752   | 9.7165   | 13.0415  | 16.5591  | 19.3269  | 20.6033  | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 222.1155 | 224.4203 | 218.6122 | 206.2472 | 190.6307 | 175.9689 | 166.1686 | 163.8637 | 169.6719 | 182.0368 | 197.6454 | 212.3151 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | (69) |
| Pumps, fans                                                                         | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | (71) |
| Water heating gains (Table 5)                                                       | 43.4533  | 42.0765  | 39.2173  | 35.3303  | 32.8067  | 29.2533  | 26.2331  | 30.1028  | 31.4778  | 35.5009  | 40.0438  | 42.0822  | (72) |
| Total internal gains                                                                | 345.9181 | 344.6048 | 332.6125 | 312.8429 | 291.9430 | 272.4435 | 260.1800 | 263.9863 | 274.4944 | 294.4001 | 317.3193 | 335.3039 | (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   |          |          |          |          | 0.7800     | 11.2829                        | 0.4500                            | 0.0000                             | 0.7700                       | 3.0494 (75)  |          |          |      |  |
| Southeast   |          |          |          |          | 5.7000     | 36.7938                        | 0.4500                            | 0.0000                             | 0.7700                       | 72.6697 (77) |          |          |      |  |
| Southwest   |          |          |          |          | 0.7800     | 36.7938                        | 0.4500                            | 0.0000                             | 0.7700                       | 9.9443 (79)  |          |          |      |  |
| Northwest   |          |          |          |          | 8.2900     | 11.2829                        | 0.4500                            | 0.0000                             | 0.7700                       | 32.4101 (81) |          |          |      |  |
|             |          |          |          |          |            |                                |                                   |                                    |                              |              |          |          |      |  |
| Solar gains | 118.0734 | 212.9010 | 322.5855 | 452.1376 | 554.2952   | 571.3404                       | 542.0716                          | 462.6387                           | 366.9423                     | 243.7362     | 143.5697 | 99.6583  | (83) |  |
| Total gains | 463.9916 | 557.5058 | 655.1980 | 764.9805 | 846.2382   | 843.7839                       | 802.2516                          | 726.6250                           | 641.4366                     | 538.1363     | 460.8890 | 434.9622 | (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                                                                         | 33.6183 | 33.6978 | 33.7761 | 34.1487 | 34.2193 | 34.5519 | 34.5519 | 34.6142 | 34.4230 | 34.2193                   | 34.0767 | 33.9289 |              |
| alpha                                                                       | 3.2412  | 3.2465  | 3.2517  | 3.2766  | 3.2813  | 3.3035  | 3.3035  | 3.3076  | 3.2949  | 3.2813                    | 3.2718  | 3.2619  |              |
| util living area                                                            | 0.9894  | 0.9803  | 0.9596  | 0.9072  | 0.8046  | 0.6528  | 0.5116  | 0.5727  | 0.7957  | 0.9423                    | 0.9825  | 0.9914  | (86)         |
| MIT                                                                         | 18.9661 | 19.2122 | 19.6154 | 20.1379 | 20.5800 | 20.8545 | 20.9518 | 20.9298 | 20.7030 | 20.1166                   | 19.4458 | 18.9238 | (87)         |
| Th 2                                                                        | 19.8689 | 19.8713 | 19.8736 | 19.8845 | 19.8865 | 19.8960 | 19.8960 | 19.8978 | 19.8923 | 19.8865                   | 19.8824 | 19.8781 | (88)         |
| util rest of house                                                          | 0.9871  | 0.9759  | 0.9503  | 0.8851  | 0.7573  | 0.5696  | 0.3977  | 0.4574  | 0.7281  | 0.9240                    | 0.9779  | 0.9895  | (89)         |
| MIT 2                                                                       | 18.0213 | 18.2669 | 18.6659 | 19.1783 | 19.5844 | 19.8162 | 19.8789 | 19.8704 | 19.7060 | 19.1700                   | 18.5088 | 17.9859 | (90)         |
| Living area fraction                                                        |         |         |         |         |         |         |         |         |         | FLA = Living area / (4) = |         | 0.2175  | (91)         |
| MIT                                                                         | 18.2268 | 18.4725 | 18.8724 | 19.3870 | 19.8009 | 20.0420 | 20.1122 | 20.1008 | 19.9228 | 19.3759                   | 18.7126 | 18.1899 | (92)         |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |                           |         | 0.0000  |              |
| adjusted MIT                                                                | 18.2268 | 18.4725 | 18.8724 | 19.3870 | 19.8009 | 20.0420 | 20.1122 | 20.1008 | 19.9228 | 19.3759                   | 18.7126 | 18.1899 | (93)         |

#### 8. Space heating requirement

|                                  |           |           |           |           |          |          |          |          |          |              |           |           |       |
|----------------------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|--------------|-----------|-----------|-------|
| Utilisation                      | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct          | Nov       | Dec       |       |
| Useful gains                     | 455.7810  | 539.9965  | 615.6406  | 667.9575  | 637.4013 | 490.7024 | 337.9282 | 348.9037 | 468.4289 | 491.4779     | 447.6090  | 428.6186  | (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                 | 1431.2662 | 1391.5686 | 1265.5815 | 1061.0201 | 817.9197 | 544.1677 | 351.2000 | 369.3913 | 584.4290 | 886.0660     | 1177.3855 | 1424.5903 | (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                | 725.7610  | 572.2565  | 483.5560  | 283.0051  | 134.3057 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 293.5736     | 525.4391  | 741.0029  | (98)  |
| Space heating                    |           |           |           |           |          |          |          |          |          |              |           | 3758.8998 | (98)  |
| Space heating per m <sup>2</sup> |           |           |           |           |          |          |          |          |          | (98) / (4) = |           | 46.2406   | (99)  |

#### 8c. Space cooling requirement

|                                                     |        |        |        |        |         |          |          |          |         |         |        |        |       |
|-----------------------------------------------------|--------|--------|--------|--------|---------|----------|----------|----------|---------|---------|--------|--------|-------|
| Calculated for June, July and August. See Table 10b | Jan    | Feb    | Mar    | Apr    | May     | Jun      | Jul      | Aug      | Sep     | Oct     | Nov    | Dec    |       |
| 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 |       |
| Heat loss rate W                                    | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 939.9431 | 739.9552 | 758.5859 | 0.0000  | 0.0000  | 0.0000 | 0.0000 | (100) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

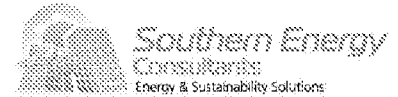


### CALCULATION OF FABRIC ENERGY EFFICIENCY 69 Jan 2014

|                                          |        |        |        |        |        |           |           |          |                          |        |        |                |
|------------------------------------------|--------|--------|--------|--------|--------|-----------|-----------|----------|--------------------------|--------|--------|----------------|
| Utilisation                              | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.8176    | 0.8752    | 0.8431   | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (101)   |
| Useful loss                              | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 768.4703  | 647.6436  | 639.5778 | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (102)   |
| Total gains                              | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1079.1348 | 1028.6698 | 941.8591 | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (103)   |
| Month fracti                             | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 1.0000    | 1.0000    | 1.0000   | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (103a)  |
| Space cooling kWh                        |        |        |        |        |        |           |           |          |                          |        |        |                |
| Space cooling                            | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 223.6784  | 283.4834  | 224.8973 | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (104)   |
| Space cooling                            |        |        |        |        |        |           |           |          |                          |        |        | 732.0592 (104) |
| Cooled fraction                          |        |        |        |        |        |           |           |          | FC = cooled area / (4) = |        |        | 1.0000 (105)   |
| Intermittency factor (Table 10b)         |        |        |        |        |        |           |           |          |                          |        |        |                |
| Intermittency factor                     | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2500    | 0.2500    | 0.2500   | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (106)   |
| Space cooling kWh                        |        |        |        |        |        |           |           |          |                          |        |        |                |
| Space cooling                            | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 55.9196   | 70.8709   | 56.2243  | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (107)   |
| Space cooling                            |        |        |        |        |        |           |           |          |                          |        |        | 183.0148 (107) |
| Space cooling per m2                     |        |        |        |        |        |           |           |          |                          |        |        | 2.2514 (108)   |
| Energy for space heating                 |        |        |        |        |        |           |           |          |                          |        |        | 46.2406 (99)   |
| Energy for space cooling                 |        |        |        |        |        |           |           |          |                          |        |        | 2.2514 (108)   |
| Total                                    |        |        |        |        |        |           |           |          |                          |        |        | 48.4920 (109)  |
| Dwelling Fabric Energy Efficiency (DFEE) |        |        |        |        |        |           |           |          |                          |        |        | 48.5 (109)     |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 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                                           | 40.6900 (1b)              | x 2.4000 (2b)                   | = 97.6560 (1b) - (3b)       |
| First floor                                            | 40.6000 (1c)              | x 2.6500 (2c)                   | = 107.5900 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 81.2900                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 205.2460 (5)              |

#### 2. Ventilation rate

|                                                                         | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|-------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                      | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                    | 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)       |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) |                 |                      |       |                             | 30.0000 / (5) = 0.1462 (8) |
| Pressure test                                                           |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                    |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                       |                 |                      |       |                             | 0.3962 (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) =        | 0.3367 (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 | 0.4293 | 0.4209 | 0.4125 | 0.3704 | 0.3620 | 0.3199 | 0.3199 | 0.3115 | 0.3367 | 0.3620 | 0.3788 | 0.3957 (22b) |
| Effective ac    | 0.5922 | 0.5886 | 0.5851 | 0.5686 | 0.5655 | 0.5512 | 0.5512 | 0.5485 | 0.5567 | 0.5655 | 0.5718 | 0.5783 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                        | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K |
|----------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|---------------|
| TER Semi-glazed door                                           |                         |                            | 2.1200                    | 1.2000                        | 2.5440       |                                | (26a)         |
| TER Opening Type (Uw = 1.40)                                   |                         |                            | 15.5500                   | 1.3258                        | 20.6155      |                                | (27)          |
| Heat Loss Floor 1                                              |                         |                            | 40.6900                   | 0.1300                        | 5.2897       |                                | (28a)         |
| Brick Faced                                                    | 93.9300                 | 17.6700                    | 76.2600                   | 0.1800                        | 13.7268      |                                | (29a)         |
| Plane Roof                                                     | 41.0600                 |                            | 41.0600                   | 0.1300                        | 5.3378       |                                | (30)          |
| Flat Roof Kitchen/Diner                                        | 2.9200                  |                            | 2.9200                    | 0.1300                        | 0.3796       |                                | (30)          |
| Total net area of external elements Aum(A, m <sup>2</sup> )    |                         |                            | 178.6000                  |                               |              |                                | (31)          |
| Fabric heat loss, W/K = Sum (A x U)                            |                         |                            |                           | (26)...(30) + (32) =          | 47.8934      |                                | (33)          |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K |                         |                            |                           |                               |              |                                | 250.0000 (35) |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)     |                         |                            |                           |                               |              |                                | 10.8427 (36)  |
| Total fabric heat loss                                         |                         |                            |                           |                               |              | (33) + (36) =                  | 58.7361 (37)  |

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

|                           | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
|---------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| (38)m                     | 40.1083 | 39.8659 | 39.6283 | 38.5122 | 38.3034 | 37.3313 | 37.3313 | 37.1513 | 37.7058 | 38.3034 | 38.7258 | 39.1674 (38) |
| Heat transfer coeff       | 98.8444 | 98.6020 | 98.3644 | 97.2483 | 97.0395 | 96.0675 | 96.0675 | 95.8875 | 96.4419 | 97.0395 | 97.4619 | 97.9036 (39) |
| Average = Sum(39)m / 12 = |         |         |         |         |         |         |         |         |         |         |         | 97.2473 (39) |
| HLP                       | 1.2159  | 1.2130  | 1.2100  | 1.1963  | 1.1937  | 1.1818  | 1.1818  | 1.1796  | 1.1864  | 1.1937  | 1.1989  | 1.2044 (40)  |
| HLP (average)             |         |         |         |         |         |         |         |         |         |         |         | 1.1963 (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                        |          |          |          |          |          |         |         |          |          |          |          | 2.4869 (42)                       |
| Average daily hot water use (litres/day) |          |          |          |          |          |         |         |          |          |          |          | 93.2634 (43)                      |
| Daily hot water use                      | 102.5898 | 98.8593  | 95.1287  | 91.3982  | 87.6676  | 83.9371 | 83.9371 | 87.6676  | 91.3982  | 95.1287  | 98.8593  | 102.5898 (44)                     |
| Energy conte                             | 152.1377 | 133.0606 | 137.3066 | 119.7072 | 114.8619 | 99.1171 | 91.8466 | 105.3953 | 106.6541 | 124.2950 | 135.6777 | 147.3372 (45)                     |
| Energy content (annual)                  |          |          |          |          |          |         |         |          |          |          |          | Total = Sum(45)m = 1467.3971 (45) |
| Distribution loss (46)m = 0.15 x (45)m   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000 (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)                       |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

### CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

|                                              |         |         |         |         |         |         |         |         |         |         |         |              |
|----------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| 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)  |
| Primary 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 (59)  |
| Heat gains from water heating, kWh/month     | 32.3293 | 28.2754 | 29.1777 | 25.4378 | 24.4082 | 21.0624 | 19.5174 | 22.3965 | 22.6640 | 26.4127 | 28.8315 | 31.3092 (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                                                                               | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | 124.3441 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 20.0461  | 17.8048  | 14.4798  | 10.9622  | 8.1943   | 6.9180   | 7.4752   | 9.7165   | 13.0415  | 16.5591  | 19.3269  | 20.6033  | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 222.1155 | 224.4203 | 218.6122 | 206.2472 | 190.6387 | 175.9689 | 166.1686 | 163.8637 | 169.6719 | 182.0368 | 197.6454 | 212.3151 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | 35.4344  | (69) |
| Pumps, fans                                                                         | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | (71) |
| Water heating gains (Table 5)                                                       | 43.4533  | 42.0765  | 39.2173  | 35.3303  | 32.8067  | 29.2533  | 26.2331  | 30.1028  | 31.4778  | 35.5009  | 40.0438  | 42.0822  | (72) |
| Total internal gains                                                                | 345.9181 | 344.6048 | 332.6125 | 312.8429 | 291.9430 | 272.4435 | 260.1800 | 263.9863 | 274.4944 | 294.4001 | 317.3193 | 335.3039 | (73) |

#### 6. Solar gains

| [Jan]     | Area<br>m <sup>2</sup> | Solar flux<br>Table 6a<br>W/m <sup>2</sup> | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W   |
|-----------|------------------------|--------------------------------------------|-----------------------------------|------------------------------------|------------------------------|--------------|
| Northeast | 0.7800                 | 11.2829                                    | 0.6300                            | 0.7000                             | 0.7700                       | 2.6896 (75)  |
| Southeast | 5.7000                 | 36.7938                                    | 0.6300                            | 0.7000                             | 0.7700                       | 64.0946 (77) |
| Southwest | 0.7800                 | 36.7938                                    | 0.6300                            | 0.7000                             | 0.7700                       | 8.7708 (79)  |
| Northwest | 8.2900                 | 11.2829                                    | 0.6300                            | 0.7000                             | 0.7700                       | 28.5857 (81) |

|             |          |          |          |          |          |          |          |          |          |          |          |          |      |
|-------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|------|
| Solar gains | 104.1408 | 187.7787 | 284.5204 | 398.7853 | 488.8884 | 503.9222 | 478.1071 | 408.0473 | 323.6431 | 214.9753 | 126.6285 | 87.8987  | (83) |
| Total gains | 450.0589 | 532.3835 | 617.1329 | 711.6282 | 780.8314 | 776.3657 | 738.2872 | 672.0336 | 598.1374 | 509.3754 | 443.9478 | 423.2025 | (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                                                                         | 57.1114 | 57.2518 | 57.3901 | 58.0487 | 58.1736 | 58.7622 | 58.7622 | 58.8725 | 58.5341                   | 58.1736 | 57.9215 | 57.6602 |              |
| alpha                                                                       | 4.8074  | 4.8168  | 4.8260  | 4.8699  | 4.8782  | 4.9175  | 4.9175  | 4.9248  | 4.9023                    | 4.8782  | 4.8614  | 4.8440  |              |
| util living area                                                            | 0.9986  | 0.9965  | 0.9900  | 0.9640  | 0.8839  | 0.7220  | 0.5562  | 0.6254  | 0.8716                    | 0.9820  | 0.9970  | 0.9990  | (86)         |
| MIT                                                                         | 19.6286 | 19.7927 | 20.0682 | 20.4378 | 20.7567 | 20.9377 | 20.9861 | 20.9761 | 20.8346                   | 20.4166 | 19.9556 | 19.6020 | (87)         |
| Th 2                                                                        | 19.9073 | 19.9096 | 19.9120 | 19.9230 | 19.9250 | 19.9346 | 19.9346 | 19.9364 | 19.9309                   | 19.9250 | 19.9208 | 19.9165 | (88)         |
| util rest of house                                                          | 0.9981  | 0.9953  | 0.9862  | 0.9498  | 0.8389  | 0.6283  | 0.4298  | 0.4958  | 0.8040                    | 0.9726  | 0.9958  | 0.9986  | (89)         |
| MIT 2                                                                       | 18.6589 | 18.8244 | 19.0999 | 19.4692 | 19.7609 | 19.9062 | 19.9311 | 19.9296 | 19.8374                   | 19.4557 | 18.9962 | 18.6397 | (90)         |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.2175  | (91)         |
| MIT                                                                         | 18.8698 | 19.0350 | 19.3105 | 19.6798 | 19.9775 | 20.1305 | 20.1606 | 20.1572 | 20.0543                   | 19.6647 | 19.2049 | 18.8490 | (92)         |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | 0.0000  |              |
| adjusted MIT                                                                | 18.8698 | 19.0350 | 19.3105 | 19.6798 | 19.9775 | 20.1305 | 20.1606 | 20.1572 | 20.0543                   | 19.6647 | 19.2049 | 18.8490 | (93)         |

#### 8. Space heating requirement

|                                  |           |           |           |           |          |          |          |          |          |              |           |           |       |
|----------------------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|--------------|-----------|-----------|-------|
| Utilisation                      | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct          | Nov       | Dec       |       |
| Useful gains                     | 0.9974    | 0.9940    | 0.9835    | 0.9457    | 0.8414   | 0.6469   | 0.4576   | 0.5243   | 0.8132   | 0.9695       | 0.9946    | 0.9981    | (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                 | 1440.1461 | 1393.7429 | 1260.0935 | 1048.3213 | 803.2451 | 531.3058 | 342.0570 | 360.2706 | 574.2429 | 879.6298     | 1179.7625 | 1434.1896 | (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                | 737.4843  | 580.9863  | 485.9554  | 270.2268  | 108.8094 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 287.0372     | 531.5147  | 752.7756  | (98)  |
| Space heating                    |           |           |           |           |          |          |          |          |          |              |           | 3754.7896 | (98)  |
| Space heating per m <sup>2</sup> |           |           |           |           |          |          |          |          |          | (98) / (4) = |           | 46.1901   | (99)  |

#### 8c. Space cooling requirement

|                                                     |        |        |        |        |         |           |          |          |         |         |        |        |        |
|-----------------------------------------------------|--------|--------|--------|--------|---------|-----------|----------|----------|---------|---------|--------|--------|--------|
| Calculated for June, July and August. See Table 10b | Jan    | Feb    | Mar    | Apr    | May     | Jun       | Jul      | Aug      | Sep     | Oct     | Nov    | Dec    |        |
| 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 |        |
| Heat loss rate W                                    | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 903.0343  | 710.8993 | 728.7448 | 0.0000  | 0.0000  | 0.0000 | 0.0000 | (100)  |
| Utilisation                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 0.8705    | 0.9272   | 0.8984   | 0.0000  | 0.0000  | 0.0000 | 0.0000 | (101)  |
| Useful loss                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 786.1185  | 659.1630 | 654.7225 | 0.0000  | 0.0000  | 0.0000 | 0.0000 | (102)  |
| Total gains                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1000.3344 | 953.9061 | 878.0510 | 0.0000  | 0.0000  | 0.0000 | 0.0000 | (103)  |
| Month fracti                                        | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1.0000    | 1.0000   | 1.0000   | 0.0000  | 0.0000  | 0.0000 | 0.0000 | (103a) |
| Space cooling kWh                                   |        |        |        |        |         |           |          |          |         |         |        |        |        |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



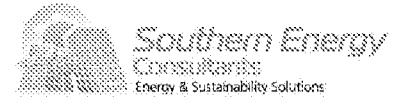
### CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

|                                        |        |        |        |        |        |          |          |          |                          |        |        |                |
|----------------------------------------|--------|--------|--------|--------|--------|----------|----------|----------|--------------------------|--------|--------|----------------|
|                                        | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 154.2354 | 219.2889 | 166.1564 | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (104)   |
| Space cooling                          |        |        |        |        |        |          |          |          |                          |        |        | 539.6808 (104) |
| Cooled fraction                        |        |        |        |        |        |          |          |          | FC = cooled area / (4) = |        |        | 1.0000 (105)   |
| Intermittency factor (Table 10b)       |        |        |        |        |        |          |          |          |                          |        |        |                |
|                                        | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2500   | 0.2500   | 0.2500   | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (106)   |
| Space cooling kWh                      |        |        |        |        |        |          |          |          |                          |        |        |                |
|                                        | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 38.5589  | 54.8222  | 41.5391  | 0.0000                   | 0.0000 | 0.0000 | 0.0000 (107)   |
| Space cooling                          |        |        |        |        |        |          |          |          |                          |        |        | 134.9202 (107) |
| Space cooling per m2                   |        |        |        |        |        |          |          |          |                          |        |        | 1.6597 (108)   |
| Energy for space heating               |        |        |        |        |        |          |          |          |                          |        |        | 46.1901 (99)   |
| Energy for space cooling               |        |        |        |        |        |          |          |          |                          |        |        | 1.6597 (108)   |
| Total                                  |        |        |        |        |        |          |          |          |                          |        |        | 47.8498 (109)  |
| Target Fabric Energy Efficiency (TFEE) |        |        |        |        |        |          |          |          |                          |        |        | 55.0 (109)     |

-----

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF HEAT DEMAND 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF HEAT DEMAND 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                                           | 40.6900 (1b)              | x 2.4000 (2b)                   | = 97.6560 (1b) - (3b)       |
| First floor                                            | 40.6000 (1c)              | x 2.6500 (2c)                   | = 107.5900 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 81.2900                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 205.2460 (5)              |

#### 2. Ventilation rate

|                                                                         | main<br>heating | secondary<br>heating | other                     | total | m3 per hour                |
|-------------------------------------------------------------------------|-----------------|----------------------|---------------------------|-------|----------------------------|
| Number of chimneys                                                      | 0               | +                    | 0                         | =     | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                    | 0               | +                    | 0                         | =     | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                             |                 |                      |                           |       | 4 * 10 = 40.0000 (7a)      |
| Number of passive vents                                                 |                 |                      |                           |       | 0 * 10 = 0.0000 (7b)       |
| Number of flueless gas fires                                            |                 |                      |                           |       | 0 * 40 = 0.0000 (7c)       |
| Air changes per hour                                                    |                 |                      |                           |       |                            |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) |                 |                      |                           |       | 40.0000 / (5) = 0.1949 (8) |
| Pressure test                                                           |                 |                      |                           |       | Yes                        |
| Measured/design AP50                                                    |                 |                      |                           |       | 5.0000                     |
| Infiltration rate                                                       |                 |                      |                           |       | 0.4449 (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)        | =     | 0.3782 (21)                |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.6000 | 5.1000 | 4.8000 | 4.5000 | 4.7000 | 4.2000 | 4.4000 | 4.2000 | 4.4000 | 4.8000 | 4.9000 | 5.1000 (22)  |
| Wind factor     | 1.4000 | 1.2750 | 1.2000 | 1.1250 | 1.1750 | 1.0500 | 1.1000 | 1.0500 | 1.1000 | 1.2000 | 1.2250 | 1.2750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac    | 0.5294 | 0.4821 | 0.4538 | 0.4254 | 0.4443 | 0.3971 | 0.4160 | 0.3971 | 0.4160 | 0.4538 | 0.4632 | 0.4821 (22b) |
|                 | 0.6401 | 0.6162 | 0.6030 | 0.5905 | 0.5987 | 0.5788 | 0.5865 | 0.5788 | 0.5865 | 0.6030 | 0.6073 | 0.6162 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                      | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K   |
|--------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|-----------------|
| Opening Type 2 (Uw = 1.30)                                   |                         |                            | 15.5500                   | 1.2357                        | 19.2158      |                                | (27)            |
| Opening Type 3                                               |                         |                            | 2.1200                    | 1.5000                        | 3.1800       |                                | (26a)           |
| Heat Loss Floor 1                                            |                         |                            | 40.6900                   | 0.1100                        | 4.4759       | 75.0000                        | 3051.7500 (28a) |
| Brick Faced                                                  | 93.9300                 | 17.6700                    | 76.2600                   | 0.2400                        | 18.3024      | 60.0000                        | 4575.6000 (29a) |
| Plane Roof                                                   | 41.0600                 |                            | 41.0600                   | 0.1100                        | 4.5166       | 9.0000                         | 369.5400 (30)   |
| Flat Roof Kitchen/Diner                                      | 2.9200                  |                            | 2.9200                    | 0.1200                        | 0.3504       | 0.0000                         | 0.0000 (30)     |
| Total net area of external elements Aum (A, m <sup>2</sup> ) |                         |                            | 178.6000                  |                               |              |                                | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                          |                         |                            |                           | (26)...(30) + (32) =          | 50.0411      |                                | (33)            |
| Party Wall 1                                                 |                         |                            | 41.3500                   | 0.0000                        | 0.0000       | 45.0000                        | 1860.7500 (32)  |
| Internal Wall 2                                              |                         |                            | 163.5200                  |                               |              | 9.0000                         | 1471.6800 (32c) |
| Internal Floor 1                                             |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32d)  |
| Internal Ceiling 1                                           |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32e)  |

Heat capacity Cm = Sum(A x k)  
Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K  
Thermal bridges (Sum(L x Psi) calculated using Appendix K)  
Total fabric heat loss

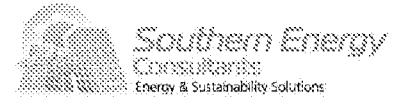
|                                                                     |                |                |                |                |                |                |                |                |                |                |                |                     |
|---------------------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|
| (28)...(30) + (32) + (32a)...(32e) = 12807.4800 (34)                |                |                |                |                |                |                |                |                |                |                |                |                     |
| 157.5530 (35)                                                       |                |                |                |                |                |                |                |                |                |                |                |                     |
| 12.6215 (36)                                                        |                |                |                |                |                |                |                |                |                |                |                |                     |
| (33) + (36) = 62.6626 (37)                                          |                |                |                |                |                |                |                |                |                |                |                |                     |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                |                |                |                |                |                |                |                |                |                     |
| (38)m                                                               | Jan<br>43.3575 | Feb<br>41.7382 | Mar<br>40.8392 | Apr<br>39.9948 | May<br>40.5517 | Jun<br>39.2048 | Jul<br>39.7254 | Aug<br>39.2048 | Sep<br>39.7254 | Oct<br>40.8392 | Nov<br>41.1328 | Dec<br>41.7382 (38) |
| Heat transfer coeff                                                 | 106.0201       | 104.4008       | 103.5018       | 102.6574       | 103.2143       | 101.8674       | 102.3880       | 101.8674       | 102.3880       | 103.5018       | 103.7954       | 104.4008 (39)       |
| Average = Sum(39)m / 12 =                                           |                |                |                |                |                |                |                |                |                |                |                | 103.3336 (39)       |
| HLP                                                                 | Jan<br>1.3042  | Feb<br>1.2843  | Mar<br>1.2732  | Apr<br>1.2629  | May<br>1.2697  | Jun<br>1.2531  | Jul<br>1.2595  | Aug<br>1.2531  | Sep<br>1.2595  | Oct<br>1.2732  | Nov<br>1.2769  | Dec<br>1.2843 (40)  |
| HLP (average)                                                       |                |                |                |                |                |                |                |                |                |                |                | 1.2712 (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                        |          |          |          |          |          |         |         |          |          |                    |          | 2.4869 (42)    |
| Average daily hot water use (litres/day) |          |          |          |          |          |         |         |          |          |                    |          | 93.2634 (43)   |
| Jan                                      | Feb      | Mar      | Apr      | May      | Jun      | Jul     | Aug     | Sep      | Oct      | Nov                | Dec      |                |
| Daily hot water use                      | 102.5898 | 98.8593  | 95.1287  | 91.3982  | 87.6676  | 83.9371 | 83.9371 | 87.6676  | 91.3982  | 95.1287            | 98.8593  | 102.5898 (44)  |
| Energy conte                             | 152.1377 | 133.0606 | 137.3066 | 119.7072 | 114.8619 | 99.1171 | 91.8466 | 105.3953 | 106.6541 | 124.2950           | 135.6777 | 147.3372 (45)  |
| Energy content (annual)                  |          |          |          |          |          |         |         |          |          | Total = Sum(45)m = |          | 1467.3971 (45) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF HEAT DEMAND 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |                |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
| Distribution loss (46)m = 0.15 x (45)m                          | 22.8207  | 19.9591  | 20.5960  | 17.9561  | 17.2293  | 14.8676  | 13.7770  | 15.8093  | 15.9981  | 18.6443  | 20.3517  | 22.1006 (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                    | 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                                                      | 14.1217  | 12.7410  | 14.0700  | 13.5754  | 13.9982  | 13.5125  | 13.9416  | 13.9783  | 13.5468  | 14.0403  | 13.6347  | 14.1102 (61)   |
| Total heat required for water heating calculated for each month | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474 (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                                                 | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474 (64)  |
| RHI water heating demand                                        |          |          |          |          |          |          |          |          |          |          |          |                |
| Heat gains from water heating, kWh/month                        | 54.1162  | 47.4279  | 49.1720  | 43.1965  | 41.6912  | 36.3346  | 34.0244  | 38.5385  | 38.8492  | 44.8382  | 48.5215  | 52.5172 (65)   |
| Solar input (sum of months) = Sum(63)m =                        |          |          |          |          |          |          |          |          |          |          |          | 0.0000 (63)    |
| Total per year (kWh/year) = Sum(64)m =                          |          |          |          |          |          |          |          |          |          |          |          | 1632.6678 (64) |

#### 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                                                                               | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 50.1153  | 44.5120  | 36.1996  | 27.4054  | 20.4859  | 17.2950  | 18.6879  | 24.2912  | 32.6036  | 41.3978  | 48.3173  | 51.5082  | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 331.5156 | 334.9557 | 326.2868 | 307.8317 | 284.5354 | 262.6402 | 248.0128 | 244.5727 | 253.2417 | 271.6968 | 294.9931 | 316.8883 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | (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)                                 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | (71) |
| Water heating gains (Table 5)                                                       | 72.7368  | 70.5772  | 66.0913  | 59.9951  | 56.0365  | 50.4647  | 45.7317  | 51.7991  | 53.9572  | 60.2664  | 67.3910  | 70.5876  | (72) |
| Total internal gains                                                                | 559.5136 | 555.1907 | 533.7235 | 500.3780 | 466.2036 | 435.5457 | 417.5782 | 425.8089 | 444.9483 | 478.5068 | 515.8472 | 544.1299 | (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   |          |          |          |           | 0.7800     | 15.8975                        | 0.4500                            |          | 0.0000                             |          | 0.7700                       | 4.2966 (75)  |      |
| Southeast   |          |          |          |           | 5.7000     | 48.9171                        | 0.4500                            |          | 0.0000                             |          | 0.7700                       | 96.6137 (77) |      |
| Southwest   |          |          |          |           | 0.7800     | 48.9171                        | 0.4500                            |          | 0.0000                             |          | 0.7700                       | 13.2208 (79) |      |
| Northwest   |          |          |          |           | 8.2900     | 15.8975                        | 0.4500                            |          | 0.0000                             |          | 0.7700                       | 45.6653 (81) |      |
|             |          |          |          |           |            |                                |                                   |          |                                    |          |                              |              |      |
| Solar gains | 159.7964 | 241.5158 | 368.1132 | 539.6873  | 642.0082   | 711.2739                       | 670.3929                          | 573.5583 | 451.2689                           | 298.2153 | 186.4811                     | 130.7072     | (83) |
| Total gains | 719.3100 | 796.7065 | 901.8367 | 1040.0654 | 1108.2118  | 1146.8195                      | 1087.9711                         | 999.3671 | 896.2172                           | 776.7221 | 702.3283                     | 674.8370     | (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                                                                         | 33.5562 | 34.0767 | 34.3727 | 34.6554 | 34.4684 | 34.9242 | 34.7466 | 34.9242 | 34.7466                   | 34.3727 | 34.2754 | 34.0767 |              |
| alpha                                                                       | 3.2371  | 3.2718  | 3.2915  | 3.3104  | 3.2979  | 3.3283  | 3.3164  | 3.3283  | 3.3164                    | 3.2915  | 3.2850  | 3.2718  |              |
| util living area                                                            | 0.9580  | 0.9430  | 0.9010  | 0.8049  | 0.6502  | 0.4571  | 0.3238  | 0.3304  | 0.5625                    | 0.8123  | 0.9274  | 0.9628  | (86)         |
| MIT                                                                         | 19.5515 | 19.7143 | 20.0747 | 20.5041 | 20.8172 | 20.9588 | 20.9903 | 20.9905 | 20.9226                   | 20.6062 | 20.0605 | 19.5540 | (87)         |
| Th 2                                                                        | 19.8375 | 19.8532 | 19.8619 | 19.8700 | 19.8646 | 19.8777 | 19.8727 | 19.8777 | 19.8727                   | 19.8619 | 19.8590 | 19.8532 | (88)         |
| util rest of house                                                          | 0.9485  | 0.9307  | 0.8799  | 0.7657  | 0.5839  | 0.3704  | 0.2221  | 0.2208  | 0.4639                    | 0.7596  | 0.9082  | 0.9542  | (89)         |
| MIT 2                                                                       | 17.9839 | 18.2243 | 18.7356 | 19.3184 | 19.6982 | 19.8522 | 19.8696 | 19.8750 | 19.8221                   | 19.4632 | 18.7261 | 17.9987 | (90)         |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.2175  | (91)         |
| MIT                                                                         | 18.3249 | 18.5483 | 19.0268 | 19.5762 | 19.9416 | 20.0929 | 20.1134 | 20.1176 | 20.0615                   | 19.7118 | 19.0164 | 18.3370 | (92)         |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500 |              |
| adjusted MIT                                                                | 18.1749 | 18.3983 | 18.8768 | 19.4262 | 19.7916 | 19.9429 | 19.9634 | 19.9676 | 19.9115                   | 19.5618 | 18.8664 | 18.1870 | (93)         |

#### 8. Space heating requirement

|                          |           |           |           |          |          |          |          |          |          |          |           |           |       |
|--------------------------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-------|
| Utilisation              | Jan       | Feb       | Mar       | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec       |       |
| Useful gains             | 668.9227  | 725.0949  | 773.1008  | 777.9556 | 641.9664 | 430.8004 | 250.6962 | 229.6399 | 418.9899 | 577.2239 | 622.5570  | 632.1969  | (94)  |
| Ext temp.                | 5.8000    | 6.0000    | 7.5000    | 9.8000   | 12.9000  | 15.6000  | 17.5000  | 17.7000  | 15.6000  | 12.5000  | 9.0000    | 6.0000    | (96)  |
| Heat loss rate W         | 1311.9848 | 1294.3975 | 1177.5234 | 988.2043 | 711.3071 | 442.3988 | 252.2190 | 230.9984 | 441.4415 | 730.9136 | 1024.0839 | 1272.3297 | (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        | 478.4382  | 382.5713  | 300.8905  | 151.3790 | 51.5894  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 114.3451 | 289.0994  | 476.2588  | (98)  |
| Space heating            |           |           |           |          |          |          |          |          |          |          |           | 2244.5717 | (98)  |
| RHI space heating demand |           |           |           |          |          |          |          |          |          |          |           | 2245      | (98)  |

# FULL SAP CALCULATION PRINTOUT

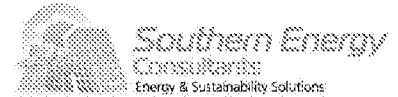
## Calculation Type: New Build (As Designed)



CALCULATION OF HEAT DEMAND 09 Jan 2014

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF ENERGY RATINGS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF ENERGY RATINGS 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                                           | 40.6900 (1b)              | x 2.4000 (2b)                   | = 97.6560 (1b) - (3b)       |
| First floor                                            | 40.6000 (1c)              | x 2.6500 (2c)                   | = 107.5900 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 81.2900                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 205.2460 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other                       | total           | m3 per hour           |
|---------------------------------------------------------------------------|-----------------|----------------------|-----------------------------|-----------------|-----------------------|
| Number of chimneys                                                        | 0               | +                    | 0                           | =               | 0 * 40 = 0.0000 (6a)  |
| Number of open flues                                                      | 0               | +                    | 0                           | =               | 0 * 20 = 0.0000 (6b)  |
| Number of intermittent fans                                               |                 |                      |                             |                 | 4 * 10 = 40.0000 (7a) |
| Number of passive vents                                                   |                 |                      |                             |                 | 0 * 10 = 0.0000 (7b)  |
| Number of flueless gas fires                                              |                 |                      |                             |                 | 0 * 40 = 0.0000 (7c)  |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = |                 |                      |                             | 40.0000 / (5) = | 0.1949 (8)            |
| Pressure test                                                             |                 |                      |                             |                 | Yes                   |
| Measured/design AP50                                                      |                 |                      |                             |                 | 5.0000                |
| Infiltration rate                                                         |                 |                      |                             |                 | 0.4449 (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) =        |                 | 0.3782 (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 | 0.4821 | 0.4727 | 0.4632 | 0.4160 | 0.4065 | 0.3592 | 0.3592 | 0.3498 | 0.3782 | 0.4065 | 0.4254 | 0.4443 (22b) |
| Effective ac    | 0.6162 | 0.6117 | 0.6073 | 0.5865 | 0.5826 | 0.5645 | 0.5645 | 0.5612 | 0.5715 | 0.5826 | 0.5905 | 0.5987 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                      | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K   |
|--------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|-----------------|
| Opening Type 2 (Uw = 1.30)                                   |                         |                            | 15.5500                   | 1.2357                        | 19.2158      |                                | (27)            |
| Opening Type 3                                               |                         |                            | 2.1200                    | 1.5000                        | 3.1800       |                                | (26a)           |
| Heat Loss Floor 1                                            |                         |                            | 40.6900                   | 0.1100                        | 4.4759       | 75.0000                        | 3051.7500 (28a) |
| Brick Faced                                                  | 93.9300                 | 17.6700                    | 76.2600                   | 0.2400                        | 18.3024      | 60.0000                        | 4575.6000 (29a) |
| Plane Roof                                                   | 41.0600                 |                            | 41.0600                   | 0.1100                        | 4.5166       | 9.0000                         | 369.5400 (30)   |
| Flat Roof Kitchen/Diner                                      | 2.9200                  |                            | 2.9200                    | 0.1200                        | 0.3504       | 0.0000                         | 0.0000 (30)     |
| Total net area of external elements Aum (A, m <sup>2</sup> ) |                         |                            | 178.6000                  |                               |              |                                | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                          |                         |                            |                           | (26)...(30) + (32) =          | 50.0411      |                                | (33)            |
| Party Wall 1                                                 |                         |                            | 41.3500                   | 0.0000                        | 0.0000       | 45.0000                        | 1860.7500 (32)  |
| Internal Wall 2                                              |                         |                            | 163.5200                  |                               |              | 9.0000                         | 1471.6800 (32c) |
| Internal Floor 1                                             |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32d)  |
| Internal Ceiling 1                                           |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32e)  |

Heat capacity Cm = Sum(A x k)  
Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K  
Thermal bridges (Sum(L x Psi) calculated using Appendix K)  
Total fabric heat loss

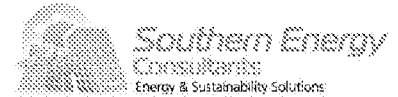
|                                                                     |          |          |          |          |          |          |          |          |          |          |          |               |
|---------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |          |          |          |          |          |          |          |          |          |          |               |
| (38)m                                                               | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
| Heat transfer coeff                                                 | 41.7382  | 41.4325  | 41.1328  | 39.7254  | 39.4621  | 38.2362  | 38.2362  | 38.0092  | 38.7084  | 39.4621  | 39.9948  | 40.5517 (38)  |
| Average = Sum(39)m / 12 =                                           | 104.4008 | 104.0951 | 103.7954 | 102.3880 | 102.1247 | 100.8988 | 100.8988 | 100.6718 | 101.3710 | 102.1247 | 102.6574 | 103.2143 (39) |
| HLP                                                                 | 1.2843   | 1.2805   | 1.2769   | 1.2595   | 1.2563   | 1.2412   | 1.2412   | 1.2384   | 1.2470   | 1.2563   | 1.2629   | 1.2697 (40)   |
| HLP (average)                                                       |          |          |          |          |          |          |          |          |          |          |          | 1.2595 (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                        |          |          |          |          |          |         |         |          |          |          |          | 2.4869 (42)    |
| Average daily hot water use (litres/day) |          |          |          |          |          |         |         |          |          |          |          | 93.2634 (43)   |
| Daily hot water use                      | Jan      | Feb      | Mar      | Apr      | May      | Jun     | Jul     | Aug      | Sep      | Oct      | Nov      | Dec            |
| Energy conte                             | 102.5898 | 98.8593  | 95.1287  | 91.3982  | 87.6676  | 83.9371 | 83.9371 | 87.6676  | 91.3982  | 95.1287  | 98.8593  | 102.5898 (44)  |
| Energy content (annual)                  | 152.1377 | 133.0606 | 137.3066 | 119.7072 | 114.8619 | 99.1171 | 91.8466 | 105.3953 | 106.6541 | 124.2950 | 135.6777 | 147.3372 (45)  |
| Total = Sum(45)m =                       |          |          |          |          |          |         |         |          |          |          |          | 1467.3971 (45) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF ENERGY RATINGS 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Distribution loss (46)m = 0.15 x (45)m                          | 22.8207  | 19.9591  | 20.5960  | 17.9561  | 17.2293  | 14.8676  | 13.7770  | 15.8093  | 15.9981  | 18.6443  | 20.3517  | 22.1006 (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                    | 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                                                      | 14.1217  | 12.7410  | 14.0700  | 13.5754  | 13.9982  | 13.5125  | 13.9416  | 13.9783  | 13.5468  | 14.0403  | 13.6347  | 14.1102 (61)  |
| Total heat required for water heating calculated for each month | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474 (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                                                 | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474 (64) |
| Heat gains from water heating, kWh/month                        | 54.1162  | 47.4279  | 49.1720  | 43.1965  | 41.6912  | 36.3346  | 34.0244  | 38.5385  | 38.8492  | 44.8382  | 48.5215  | 52.5172 (65)  |
| Solar input (sum of months) = Sum(63)m = 0.0000 (63)            |          |          |          |          |          |          |          |          |          |          |          |               |
| Total per year (kWh/year) = Sum(64)m = 1632.6678 (64)           |          |          |          |          |          |          |          |          |          |          |          |               |

#### 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                                                                               | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 50.1153  | 44.5120  | 36.1996  | 27.4054  | 20.4859  | 17.2950  | 18.6879  | 24.2912  | 32.6036  | 41.3978  | 48.3173  | 51.5082 (67)  |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 331.5156 | 334.9557 | 326.2868 | 307.8317 | 284.5354 | 262.6402 | 248.0128 | 244.5727 | 253.2417 | 271.6968 | 294.9931 | 316.8883 (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082 (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)                                 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 (71) |
| Water heating gains (Table 5)                                                       | 72.7368  | 70.5772  | 66.0913  | 59.9951  | 56.0365  | 50.4647  | 45.7317  | 51.7991  | 53.9572  | 60.2664  | 67.3910  | 70.5876 (72)  |
| Total internal gains                                                                | 559.5136 | 555.1907 | 533.7235 | 500.3780 | 466.2036 | 435.5457 | 417.5782 | 425.8089 | 444.9483 | 478.5068 | 515.8472 | 544.1299 (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   |          |          |          |          | 0.7800     | 11.2829                        | 0.4500                            | 0.0000                             | 0.7700                       | 3.0494 (75)  |          |               |
| Southeast   |          |          |          |          | 5.7000     | 36.7938                        | 0.4500                            | 0.0000                             | 0.7700                       | 72.6697 (77) |          |               |
| Southwest   |          |          |          |          | 0.7800     | 36.7938                        | 0.4500                            | 0.0000                             | 0.7700                       | 9.9443 (79)  |          |               |
| Northwest   |          |          |          |          | 8.2900     | 11.2829                        | 0.4500                            | 0.0000                             | 0.7700                       | 32.4101 (81) |          |               |
| <hr/>       |          |          |          |          |            |                                |                                   |                                    |                              |              |          |               |
| Solar gains | 118.0734 | 212.9010 | 322.5855 | 452.1376 | 554.2952   | 571.3404                       | 542.0716                          | 462.6387                           | 366.9423                     | 243.7362     | 143.5697 | 99.6583 (83)  |
| Total gains | 677.5870 | 768.0917 | 856.3090 | 952.5156 | 1020.4988  | 1006.8861                      | 959.6498                          | 888.4475                           | 811.8905                     | 722.2430     | 659.4169 | 643.7882 (84) |

#### 7. Mean internal temperature (heating season)

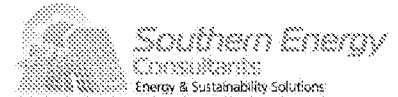
|                                                                             |         |         |         |         |         |         |         |         |                           |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| 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                                                                         | 34.0767 | 34.1768 | 34.2754 | 34.7466 | 34.8362 | 35.2594 | 35.2594 | 35.3389 | 35.0952                   | 34.8362 | 34.6554 | 34.4684      |
| alpha                                                                       | 3.2718  | 3.2785  | 3.2850  | 3.3164  | 3.3224  | 3.3506  | 3.3506  | 3.3559  | 3.3397                    | 3.3224  | 3.3104  | 3.2979       |
| util living area                                                            | 0.9717  | 0.9565  | 0.9258  | 0.8575  | 0.7403  | 0.5806  | 0.4432  | 0.4915  | 0.7093                    | 0.8905  | 0.9567  | 0.9757 (86)  |
| MIT                                                                         | 19.2878 | 19.5133 | 19.8739 | 20.3298 | 20.6913 | 20.9025 | 20.9702 | 20.9578 | 20.8031                   | 20.3342 | 19.7370 | 19.2486 (87) |
| Th 2                                                                        | 19.8532 | 19.8561 | 19.8590 | 19.8727 | 19.8752 | 19.8872 | 19.8872 | 19.8894 | 19.8826                   | 19.8752 | 19.8700 | 19.8646 (88) |
| util rest of house                                                          | 0.9658  | 0.9475  | 0.9101  | 0.8273  | 0.6865  | 0.4982  | 0.3391  | 0.3846  | 0.6326                    | 0.8602  | 0.9461  | 0.9706 (89)  |
| MIT 2                                                                       | 17.6127 | 17.9380 | 18.4528 | 19.0925 | 19.5625 | 19.8127 | 19.8726 | 19.8669 | 19.7133                   | 19.1166 | 18.2736 | 17.5636 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.2175 (91)  |
| MIT                                                                         | 17.9770 | 18.2806 | 18.7619 | 19.3616 | 19.8080 | 20.0497 | 20.1113 | 20.1042 | 19.9503                   | 19.3815 | 18.5918 | 17.9300 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500      |
| adjusted MIT                                                                | 17.8270 | 18.1306 | 18.6119 | 19.2116 | 19.6580 | 19.8997 | 19.9613 | 19.9542 | 19.8003                   | 19.2315 | 18.4418 | 17.7800 (93) |

#### 8. Space heating requirement

|                           |           |           |           |           |          |          |          |          |          |          |           |                |
|---------------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------|
| Utilisation               | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec            |
| Useful gains              | 0.9508    | 0.9289    | 0.8881    | 0.8062    | 0.6749   | 0.4992   | 0.3463   | 0.3911   | 0.6263   | 0.8386   | 0.9277    | 0.9569 (94)    |
| Ext temp.                 | 644.2518  | 713.5180  | 760.4776  | 767.9102  | 688.6852 | 502.6043 | 332.3578 | 347.5109 | 508.4852 | 605.6723 | 611.7637  | 616.0582 (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              | 1412.2335 | 1377.2434 | 1257.1590 | 1055.7840 | 812.7090 | 534.7370 | 339.1532 | 357.8058 | 577.8467 | 881.4847 | 1164.3244 | 1401.6548 (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             | 571.3784  | 446.0235  | 369.5309  | 207.2692  | 92.2738  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 205.2044 | 397.8437  | 584.4839 (98)  |
| Space heating per m2      |           |           |           |           |          |          |          |          |          |          |           | 2874.0077 (98) |
| (98) / (4) = 35.3550 (99) |           |           |           |           |          |          |          |          |          |          |           |                |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF ENERGY RATINGS 09 Jan 2014

8c. Space cooling requirement

Not applicable

#### 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                                             |          |          |          |          |          |          |          |          |           |          |          |           | 3175.6991 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep       | Oct      | Nov      | Dec       |                 |
| Space heating requirement                                             | 571.3784 | 446.0235 | 369.5309 | 207.2692 | 92.2738  | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 205.2044 | 397.8437 | 584.4839  | (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)                              | 631.3573 | 492.8436 | 408.3215 | 229.0267 | 101.9600 | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 226.7452 | 439.6063 | 645.8385  | (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                                             | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008  | 138.3354 | 149.3124 | 161.4474  | (64)            |
| Efficiency of water heater (217)m                                     | 89.7584  | 89.6901  | 89.5461  | 89.2201  | 88.6074  | 87.3000  | 87.3000  | 87.3000  | 87.3000   | 89.1836  | 89.6037  | 89.7877   | (217)           |
| Fuel for water heating, kWh/month                                     | 185.2298 | 162.5616 | 169.0488 | 149.3864 | 145.4283 | 129.0144 | 121.1777 | 136.7395 | 137.6871  | 155.1129 | 166.6364 | 179.8102  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |           |          |          | 1837.8332 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |           |          |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |           |          |          | 3175.6991 | (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)                   |          |          |          |          |          |          |          |          |           |          |          |           | 354.0209 (232)  |
| Energy saving/generation technologies (Appendices M,N and Q)          |          |          |          |          |          |          |          |          |           |          |          |           |                 |
| PV Unit 0 (0.80 * 0.75 * 1029 * 0.80) =                               |          |          |          |          |          |          |          |          | -494.0096 |          |          |           | -494.0096 (233) |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |           |          |          |           | 4948.5436 (238) |

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

|                                       | Fuel<br>kWh/year | Fuel price<br>p/kWh | Fuel cost<br>£/year |       |
|---------------------------------------|------------------|---------------------|---------------------|-------|
| Space heating - main system 1         | 3175.6991        | 3.4800              | 110.5143            | (240) |
| Space heating - secondary             | 0.0000           | 0.0000              | 0.0000              | (242) |
| Water heating (other fuel)            | 1837.8332        | 3.4800              | 63.9566             | (247) |
| Pumps and fans for heating            | 75.0000          | 13.1900             | 9.8925              | (249) |
| Energy for lighting                   | 354.0209         | 13.1900             | 46.6954             | (250) |
| Additional standing charges           |                  |                     | 120.0000            | (251) |
| Energy saving/generation technologies |                  |                     |                     |       |
| PV Unit                               | -494.0096        | 13.1900             | -65.1599            | (252) |
| Total energy cost                     |                  |                     | 285.8989            | (255) |

#### 11a. SAP rating - Individual heating systems

|                                  |                                  |              |
|----------------------------------|----------------------------------|--------------|
| Energy cost deflator (Table 12): |                                  | 0.4200 (256) |
| Energy cost factor (ECF)         | [(255) x (256)] / [(4) + 45.0] = | 0.9508 (257) |
| SAP value                        |                                  | 86.7362      |
| SAP rating (Section 12)          |                                  | 87 (258)     |
| SAP band                         |                                  | B            |

#### 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         | 3175.6991          | 0.2160                        | 685.9510                 | (261) |
| Space heating - secondary             | 0.0000             | 0.0000                        | 0.0000                   | (263) |
| Water heating (other fuel)            | 1837.8332          | 0.2160                        | 396.9720                 | (264) |
| Space and water heating               |                    |                               | 1082.9230                | (265) |
| Pumps and fans                        | 75.0000            | 0.5190                        | 38.9250                  | (267) |
| Energy for lighting                   | 354.0209           | 0.5190                        | 183.7368                 | (268) |
| Energy saving/generation technologies |                    |                               |                          |       |
| PV Unit                               | -494.0096          | 0.5190                        | -256.3910                | (269) |
| Total kg/year                         |                    |                               | 1049.1938                | (272) |
| CO2 emissions per m2                  |                    |                               | 12.9100                  | (273) |
| EI value                              |                    |                               | 88.8675                  |       |
| EI rating                             |                    |                               | 89                       | (274) |
| EI band                               |                    |                               | B                        |       |

Calculation of stars for heating and DHW

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

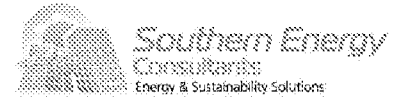


CALCULATION OF ENERGY RATINGS 09 Jan 2014

|                                    |                                                                     |
|------------------------------------|---------------------------------------------------------------------|
| Main heating energy efficiency     | $3.48 \times (1 + 0.29 \times 0.00) / 0.9050 = 3.845$ , stars = 4   |
| Main heating environmental impact  | $0.216 \times (1 + 0.29 \times 0.00) / 0.9050 = 0.2387$ , stars = 4 |
| Water heating energy efficiency    | $3.48 / 0.8872 = 3.923$ , stars = 4                                 |
| Water heating environmental impact | $0.216 / 0.8872 = 0.2435$ , stars = 4                               |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 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                                           | 40.6900 (1b)              | x 2.4000 (2b)                   | = 97.6560 (1b) - (3b)       |
| First floor                                            | 40.6000 (1c)              | x 2.6500 (2c)                   | = 107.5900 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 81.2900                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 205.2460 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other                       | total | m3 per hour                |
|---------------------------------------------------------------------------|-----------------|----------------------|-----------------------------|-------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0                           | =     | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 0               | +                    | 0                           | =     | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                               |                 |                      |                             |       | 4 * 10 = 40.0000 (7a)      |
| Number of passive vents                                                   |                 |                      |                             |       | 0 * 10 = 0.0000 (7b)       |
| Number of flueless gas fires                                              |                 |                      |                             |       | 0 * 40 = 0.0000 (7c)       |
| Air changes per hour                                                      |                 |                      |                             |       |                            |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = |                 |                      |                             |       | 40.0000 / (5) = 0.1949 (8) |
| Pressure test                                                             |                 |                      |                             |       | Yes                        |
| Measured/design AP50                                                      |                 |                      |                             |       | 5.0000                     |
| Infiltration rate                                                         |                 |                      |                             |       | 0.4449 (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) =        |       | 0.3782 (21)                |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.6000 | 5.1000 | 4.8000 | 4.5000 | 4.7000 | 4.2000 | 4.4000 | 4.2000 | 4.4000 | 4.8000 | 4.9000 | 5.1000 (22)  |
| Wind factor     | 1.4000 | 1.2750 | 1.2000 | 1.1250 | 1.1750 | 1.0500 | 1.1000 | 1.0500 | 1.1000 | 1.2000 | 1.2250 | 1.2750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac    | 0.5294 | 0.4821 | 0.4538 | 0.4254 | 0.4443 | 0.3971 | 0.4160 | 0.3971 | 0.4160 | 0.4538 | 0.4632 | 0.4821 (22b) |
|                 | 0.6401 | 0.6162 | 0.6030 | 0.5905 | 0.5987 | 0.5788 | 0.5865 | 0.5788 | 0.5865 | 0.6030 | 0.6073 | 0.6162 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                     | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K   |
|-------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|-----------------|
| Opening Type 2 (Uw = 1.30)                                  |                         |                            | 15.5500                   | 1.2357                        | 19.2158      |                                | (27)            |
| Opening Type 3                                              |                         |                            | 2.1200                    | 1.5000                        | 3.1800       |                                | (26a)           |
| Heat Loss Floor 1                                           |                         |                            | 40.6900                   | 0.1100                        | 4.4759       | 75.0000                        | 3051.7500 (28a) |
| Brick Faced                                                 | 93.9300                 | 17.6700                    | 76.2600                   | 0.2400                        | 18.3024      | 60.0000                        | 4575.6000 (29a) |
| Plane Roof                                                  | 41.0600                 |                            | 41.0600                   | 0.1100                        | 4.5166       | 9.0000                         | 369.5400 (30)   |
| Flat Roof Kitchen/Diner                                     | 2.9200                  |                            | 2.9200                    | 0.1200                        | 0.3504       | 0.0000                         | 0.0000 (30)     |
| Total net area of external elements Aum(A, m <sup>2</sup> ) |                         |                            | 178.6000                  |                               |              |                                | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                         |                         |                            |                           | (26)...(30) + (32) =          | 50.0411      |                                | (33)            |
| Party Wall 1                                                |                         |                            | 41.3500                   | 0.0000                        | 0.0000       | 45.0000                        | 1860.7500 (32)  |
| Internal Wall 2                                             |                         |                            | 163.5200                  |                               |              | 9.0000                         | 1471.6800 (32c) |
| Internal Floor 1                                            |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32d)  |
| Internal Ceiling 1                                          |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32e)  |

Heat capacity Cm = Sum(A x k)  
Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K  
Thermal bridges (Sum(L x Psi) calculated using Appendix K)  
Total fabric heat loss

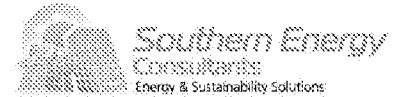
|                                                                     |                |                |                |                |                |                |                |                |                |                |                |                     |
|---------------------------------------------------------------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|----------------|---------------------|
| (28)...(30) + (32) + (32a)...(32e) = 12807.4800 (34)                |                |                |                |                |                |                |                |                |                |                |                |                     |
| 157.5530 (35)                                                       |                |                |                |                |                |                |                |                |                |                |                |                     |
| 12.6215 (36)                                                        |                |                |                |                |                |                |                |                |                |                |                |                     |
| (33) + (36) = 62.6626 (37)                                          |                |                |                |                |                |                |                |                |                |                |                |                     |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                |                |                |                |                |                |                |                |                |                     |
| (38)m                                                               | Jan<br>43.3575 | Feb<br>41.7382 | Mar<br>40.8392 | Apr<br>39.9948 | May<br>40.5517 | Jun<br>39.2048 | Jul<br>39.7254 | Aug<br>39.2048 | Sep<br>39.7254 | Oct<br>40.8392 | Nov<br>41.1328 | Dec<br>41.7382 (38) |
| Heat transfer coeff                                                 | 106.0201       | 104.4008       | 103.5018       | 102.6574       | 103.2143       | 101.8674       | 102.3880       | 101.8674       | 102.3880       | 103.5018       | 103.7954       | 104.4008 (39)       |
| Average = Sum(39)m / 12 =                                           |                |                |                |                |                |                |                |                |                |                |                | 103.3336 (39)       |
| HLP                                                                 | Jan<br>1.3042  | Feb<br>1.2843  | Mar<br>1.2732  | Apr<br>1.2629  | May<br>1.2697  | Jun<br>1.2531  | Jul<br>1.2595  | Aug<br>1.2531  | Sep<br>1.2595  | Oct<br>1.2732  | Nov<br>1.2769  | Dec<br>1.2843 (40)  |
| HLP (average)                                                       |                |                |                |                |                |                |                |                |                |                |                | 1.2712 (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                        |          |          |          |          |          |         |         |          |          |                    |          | 2.4869 (42)    |
| Average daily hot water use (litres/day) |          |          |          |          |          |         |         |          |          |                    |          | 93.2634 (43)   |
| Jan                                      | Feb      | Mar      | Apr      | May      | Jun      | Jul     | Aug     | Sep      | Oct      | Nov                | Dec      |                |
| Daily hot water use                      | 102.5898 | 98.8593  | 95.1287  | 91.3982  | 87.6676  | 83.9371 | 83.9371 | 87.6676  | 91.3982  | 95.1287            | 98.8593  | 102.5898 (44)  |
| Energy conte                             | 152.1377 | 133.0606 | 137.3066 | 119.7072 | 114.8619 | 99.1171 | 91.8466 | 105.3953 | 106.6541 | 124.2950           | 135.6777 | 147.3372 (45)  |
| Energy content (annual)                  |          |          |          |          |          |         |         |          |          | Total = Sum(45)m = |          | 1467.3971 (45) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

|                                                                 |          |          |          |          |          |          |          |          |          |          |          |               |
|-----------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Distribution loss (46)m = 0.15 x (45)m                          | 22.8207  | 19.9591  | 20.5960  | 17.9561  | 17.2293  | 14.8676  | 13.7770  | 15.8093  | 15.9981  | 18.6443  | 20.3517  | 22.1006 (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                    | 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                                                      | 14.1217  | 12.7410  | 14.0700  | 13.5754  | 13.9982  | 13.5125  | 13.9416  | 13.9783  | 13.5468  | 14.0403  | 13.6347  | 14.1102 (61)  |
| Total heat required for water heating calculated for each month | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474 (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                                                 | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474 (64) |
| Heat gains from water heating, kWh/month                        | 54.1162  | 47.4279  | 49.1720  | 43.1965  | 41.6912  | 36.3346  | 34.0244  | 38.5385  | 38.8492  | 44.8382  | 48.5215  | 52.5172 (65)  |
| Solar input (sum of months) = Sum(63)m = 0.0000 (63)            |          |          |          |          |          |          |          |          |          |          |          |               |
| Total per year (kWh/year) = Sum(64)m = 1632.6678 (64)           |          |          |          |          |          |          |          |          |          |          |          |               |

#### 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                                                                               | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 50.1153  | 44.5120  | 36.1996  | 27.4054  | 20.4859  | 17.2950  | 18.6879  | 24.2912  | 32.6036  | 41.3978  | 48.3173  | 51.5082 (67)  |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 331.5156 | 334.9557 | 326.2868 | 307.8317 | 284.5354 | 262.6402 | 248.0128 | 244.5727 | 253.2417 | 271.6968 | 294.9931 | 316.8883 (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082 (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)                                 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 (71) |
| Water heating gains (Table 5)                                                       | 72.7368  | 70.5772  | 66.0913  | 59.9951  | 56.0365  | 50.4647  | 45.7317  | 51.7991  | 53.9572  | 60.2664  | 67.3910  | 70.5876 (72)  |
| Total internal gains                                                                | 559.5136 | 555.1907 | 533.7235 | 500.3780 | 466.2036 | 435.5457 | 417.5782 | 425.8089 | 444.9483 | 478.5068 | 515.8472 | 544.1299 (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 | 0.7800     | 15.8975                        | 0.4500                       | 0.0000                       | 0.7700                       | 4.2966 (75)  |
| Southeast | 5.7000     | 48.9171                        | 0.4500                       | 0.0000                       | 0.7700                       | 96.6137 (77) |
| Southwest | 0.7800     | 48.9171                        | 0.4500                       | 0.0000                       | 0.7700                       | 13.2208 (79) |
| Northwest | 8.2900     | 15.8975                        | 0.4500                       | 0.0000                       | 0.7700                       | 45.6653 (81) |

|             |          |          |          |           |           |           |           |          |          |          |          |               |
|-------------|----------|----------|----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|---------------|
| Solar gains | 159.7964 | 241.5158 | 368.1132 | 539.6873  | 642.0082  | 711.2739  | 670.3929  | 573.5583 | 451.2689 | 298.2153 | 186.4811 | 130.7072 (83) |
| Total gains | 719.3100 | 796.7065 | 901.8367 | 1040.0654 | 1108.2118 | 1146.8195 | 1087.9711 | 999.3671 | 896.2172 | 776.7221 | 702.3283 | 674.8370 (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                                                                         | 33.5562 | 34.0767 | 34.3727 | 34.6554 | 34.4684 | 34.9242 | 34.7466 | 34.9242 | 34.7466                   | 34.3727 | 34.2754 | 34.0767      |
| alpha                                                                       | 3.2371  | 3.2718  | 3.2915  | 3.3104  | 3.2979  | 3.3283  | 3.3164  | 3.3283  | 3.3164                    | 3.2915  | 3.2850  | 3.2718       |
| util living area                                                            | 0.9580  | 0.9430  | 0.9010  | 0.8049  | 0.6502  | 0.4571  | 0.3238  | 0.3304  | 0.5625                    | 0.8123  | 0.9274  | 0.9628 (86)  |
| MIT                                                                         | 19.5515 | 19.7143 | 20.0747 | 20.5041 | 20.8172 | 20.9588 | 20.9903 | 20.9905 | 20.9226                   | 20.6062 | 20.0605 | 19.5540 (87) |
| Th 2                                                                        | 19.8375 | 19.8532 | 19.8619 | 19.8700 | 19.8646 | 19.8777 | 19.8727 | 19.8777 | 19.8727                   | 19.8619 | 19.8590 | 19.8532 (88) |
| util rest of house                                                          | 0.9485  | 0.9307  | 0.8799  | 0.7657  | 0.5839  | 0.3704  | 0.2221  | 0.2208  | 0.4639                    | 0.7596  | 0.9082  | 0.9542 (89)  |
| MIT 2                                                                       | 17.9839 | 18.2243 | 18.7356 | 19.3184 | 19.6982 | 19.8522 | 19.8696 | 19.8750 | 19.8221                   | 19.4632 | 18.7261 | 17.9987 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.2175 (91)  |
| MIT                                                                         | 18.3249 | 18.5483 | 19.0268 | 19.5762 | 19.9416 | 20.0929 | 20.1134 | 20.1176 | 20.0615                   | 19.7118 | 19.0164 | 18.3370 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500      |
| adjusted MIT                                                                | 18.1749 | 18.3983 | 18.8768 | 19.4262 | 19.7916 | 19.9429 | 19.9634 | 19.9676 | 19.9115                   | 19.5618 | 18.8664 | 18.1870 (93) |

#### 8. Space heating requirement

|                      |           |           |           |          |          |          |          |          |          |              |           |                |
|----------------------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|--------------|-----------|----------------|
| Utilisation          | Jan       | Feb       | Mar       | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct          | Nov       | Dec            |
| Useful gains         | 668.9227  | 725.0949  | 773.1008  | 777.9556 | 641.9664 | 430.8004 | 250.6962 | 229.6399 | 418.9899 | 577.2239     | 622.5570  | 632.1969 (95)  |
| Ext temp.            | 5.8000    | 6.0000    | 7.5000    | 9.8000   | 12.9000  | 15.6000  | 17.5000  | 17.7000  | 15.6000  | 12.5000      | 9.0000    | 6.0000 (96)    |
| Heat loss rate W     | 1311.9848 | 1294.3975 | 1177.5234 | 988.2043 | 711.3071 | 442.3988 | 252.2190 | 230.9984 | 441.4415 | 730.9136     | 1024.0839 | 1272.3297 (97) |
| Month fracti         | 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 kWh    | 478.4382  | 382.5713  | 300.8905  | 151.3790 | 51.5894  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 114.3451     | 289.0994  | 476.2588 (98)  |
| Space heating        |           |           |           |          |          |          |          |          |          |              |           | 2244.5717 (98) |
| Space heating per m2 |           |           |           |          |          |          |          |          |          | (98) / (4) = |           | 27.6119 (99)   |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

### Calculation of EPC Costs, Emissions and Primary Energy 09 Jan 2014

8c. Space cooling requirement

Not applicable

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                                             |          |          |          |          |          |          |          |          |          |           |          |           | 2480.1898 | (211)  |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct       | Nov      | Dec       |           |        |
| Space heating requirement                                             | 478.4382 | 382.5713 | 300.8905 | 151.3790 | 51.5894  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 114.3451  | 289.0994 | 476.2588  | (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)                              | 528.6610 | 422.7307 | 332.4757 | 167.2697 | 57.0049  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 126.3482  | 319.4468 | 526.2528  | (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                                             | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602 | 112.6296 | 105.7882 | 119.3736 | 120.2008 | 138.3354  | 149.3124 | 161.4474  | (64)      |        |
| Efficiency of water heater (217)m                                     | 89.6525  | 89.5938  | 89.4031  | 88.9730  | 88.1915  | 87.3000  | 87.3000  | 87.3000  | 87.3000  | 88.7196   | 89.3841  | 89.6679   | (216)     |        |
| Fuel for water heating, kWh/month                                     | 185.4486 | 162.7363 | 169.3192 | 149.8012 | 146.1140 | 129.0144 | 121.1777 | 136.7395 | 137.6871 | 155.9242  | 167.0458 | 180.0504  | (219)     |        |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |           |          | 1841.0585 | (219)     |        |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |           |          |           |           |        |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |           |          |           | 2480.1898 | (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)                   |          |          |          |          |          |          |          |          |          |           |          |           | 354.0209  | (232)  |
| Energy saving/generation technologies (Appendices M,N and Q)          |          |          |          |          |          |          |          |          |          |           |          |           |           |        |
| PV Unit 0 (0.80 * 0.75 * 1252 * 0.80) =                               |          |          |          |          |          |          |          |          |          | -600.8139 |          |           | -600.8139 | (233)  |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |           |          |           | 4149.4553 | (238)  |

10a. Fuel costs - using BEDF prices (491)

|                                       | Fuel<br>kWh/year | Fuel price<br>p/kWh | Fuel cost<br>£/year |
|---------------------------------------|------------------|---------------------|---------------------|
| Space heating - main system 1         | 2480.1898        | 3.6300              | 90.0309 (240)       |
| Space heating - secondary             | 0.0000           | 0.0000              | 0.0000 (242)        |
| Water heating (other fuel)            | 1841.0585        | 3.6300              | 66.8304 (247)       |
| Pumps and fans for heating            | 75.0000          | 19.4400             | 14.5800 (249)       |
| Energy for lighting                   | 354.0209         | 19.4400             | 68.8217 (250)       |
| Additional standing charges           |                  |                     | 95.0000 (251)       |
| Energy saving/generation technologies |                  |                     |                     |
| PV Unit                               | -600.8139        | 19.4400             | -116.7982 (252)     |
| Total energy cost                     |                  |                     | 218.4647 (255)      |

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

|                                       | Energy<br>kWh/year | Emission factor<br>kg CO2/kWh | Emissions<br>kg CO2/year |
|---------------------------------------|--------------------|-------------------------------|--------------------------|
| Space heating - main system 1         | 2480.1898          | 0.2160                        | 535.7210 (261)           |
| Space heating - secondary             | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)            | 1841.0585          | 0.2160                        | 397.6686 (264)           |
| Space and water heating               |                    |                               | 933.3896 (265)           |
| Pumps and fans                        | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                   | 354.0209           | 0.5190                        | 183.7368 (268)           |
| Energy saving/generation technologies |                    |                               |                          |
| PV Unit                               | -600.8139          | 0.5190                        | -311.8224 (269)          |
| Total kg/year                         |                    |                               | 844.2290 (272)           |

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

|                                       | Energy<br>kWh/year | Primary energy factor<br>kg CO2/kWh | Primary energy<br>kWh/year |
|---------------------------------------|--------------------|-------------------------------------|----------------------------|
| Space heating - main system 1         | 2480.1898          | 1.2200                              | 3025.8315 (261)            |
| Space heating - secondary             | 0.0000             | 0.0000                              | 0.0000 (263)               |
| Water heating (other fuel)            | 1841.0585          | 1.2200                              | 2246.0914 (264)            |
| Space and water heating               |                    |                                     | 5271.9229 (265)            |
| Pumps and fans                        | 75.0000            | 3.0700                              | 230.2500 (267)             |
| Energy for lighting                   | 354.0209           | 3.0700                              | 1086.8441 (268)            |
| Energy saving/generation technologies |                    |                                     |                            |
| PV Unit                               | -600.8139          | 3.0700                              | -1844.4987 (269)           |
| Primary energy kWh/year               |                    |                                     | 4744.5183 (272)            |
| Primary energy kWh/m2/year            |                    |                                     | 58.3653 (273)              |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

#### SAP 2012 EPC IMPROVEMENTS

Current energy efficiency rating: B 87  
Current environmental impact rating: B 89

#### (For testing purposes):

|                             |                   |
|-----------------------------|-------------------|
| A                           | Not considered    |
| B                           | Not considered    |
| C                           | Not considered    |
| D                           | Not considered    |
| E Low energy lighting       | Already installed |
| F                           | Not considered    |
| G                           | Not considered    |
| H                           | Not considered    |
| I                           | Not considered    |
| J                           | Not considered    |
| K                           | Not considered    |
| M                           | Not considered    |
| N Solar water heating       | Recommended       |
| O                           | Not considered    |
| P                           | Not considered    |
| R                           | Not considered    |
| S                           | Not considered    |
| T                           | Not considered    |
| U Solar photovoltaic panels | Already installed |
| A2                          | Not considered    |
| A3                          | Not considered    |
| T2                          | Not considered    |
| W                           | Not considered    |
| X                           | Not considered    |
| Y                           | Not considered    |
| J2                          | Not considered    |
| Q2                          | Not considered    |
| Z1                          | Not considered    |
| Z2                          | Not considered    |
| Z3                          | Not considered    |
| Z4                          | Not considered    |
| Z5                          | Not considered    |
| V2 Wind turbine             | Not applicable    |
| L2                          | Not considered    |
| Q3                          | Not considered    |
| O3                          | Not considered    |

| Recommended measures: | SAP change | Cost change | CO2 change      |
|-----------------------|------------|-------------|-----------------|
| N Solar water heating | + 1.2      | -£ 26       | -189 kg (22.4%) |

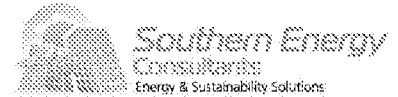
| Recommended measures                   | Typical annual savings | Energy efficiency | Environmental impact |
|----------------------------------------|------------------------|-------------------|----------------------|
| Solar water heating                    | £26 2.32 kg/m²         | B 88              | B 91                 |
| Total Savings                          | £26 2.32 kg/m²         |                   |                      |
| Potential energy efficiency rating:    |                        | B 88              |                      |
| Potential environmental impact rating: |                        |                   | B 91                 |

Fuel prices for cost data on this page from database revision number 491 TEST (28 Feb 2022)  
Recommendation texts revision number 4.9c (22 Feb 2014)

| Typical heating and lighting costs of this home (per year, Thames Valley): |            |            |            |
|----------------------------------------------------------------------------|------------|------------|------------|
|                                                                            | Current    | Potential  | Saving     |
| Electricity                                                                | £83        | £93        | -£10       |
| Mains gas                                                                  | £252       | £216       | £36        |
| Space heating                                                              | £200       | £200       | £0         |
| Water heating                                                              | £67        | £40        | £26        |
| Lighting                                                                   | £69        | £69        | £0         |
| Generated (PV)                                                             | -£117      | -£117      | £0         |
| Total cost of fuels                                                        | £218       | £192       | £26        |
| Total cost of uses                                                         | £219       | £192       | £26        |
| Delivered energy                                                           | 51 kWh/m²  | 39 kWh/m²  | 12 kWh/m²  |
| Carbon dioxide emissions                                                   | 0.8 tonnes | 0.7 tonnes | 0.2 tonnes |
| CO2 emissions per m²                                                       | 10 kg/m²   | 8 kg/m²    | 2 kg/m²    |
| Primary energy                                                             | 58 kWh/m²  | 45 kWh/m²  | 13 kWh/m²  |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 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                                           | 40.6900 (1b)              | x 2.4000 (2b)                   | = 97.6560 (1b) - (3b)       |
| First floor                                            | 40.6000 (1c)              | x 2.6500 (2c)                   | = 107.5900 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 81.2900                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 205.2460 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other                       | total           | m3 per hour           |
|---------------------------------------------------------------------------|-----------------|----------------------|-----------------------------|-----------------|-----------------------|
| Number of chimneys                                                        | 0               | +                    | 0                           | =               | 0 * 40 = 0.0000 (6a)  |
| Number of open flues                                                      | 0               | +                    | 0                           | =               | 0 * 20 = 0.0000 (6b)  |
| Number of intermittent fans                                               |                 |                      |                             |                 | 4 * 10 = 40.0000 (7a) |
| Number of passive vents                                                   |                 |                      |                             |                 | 0 * 10 = 0.0000 (7b)  |
| Number of flueless gas fires                                              |                 |                      |                             |                 | 0 * 40 = 0.0000 (7c)  |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = |                 |                      |                             | 40.0000 / (5) = | 0.1949 (8)            |
| Pressure test                                                             |                 |                      |                             |                 | Yes                   |
| Measured/design AP50                                                      |                 |                      |                             |                 | 5.0000                |
| Infiltration rate                                                         |                 |                      |                             |                 | 0.4449 (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) =        |                 | 0.3782 (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 | 0.4821 | 0.4727 | 0.4632 | 0.4160 | 0.4065 | 0.3592 | 0.3592 | 0.3498 | 0.3782 | 0.4065 | 0.4254 | 0.4443 (22b) |
| Effective ac    | 0.6162 | 0.6117 | 0.6073 | 0.5865 | 0.5826 | 0.5645 | 0.5645 | 0.5612 | 0.5715 | 0.5826 | 0.5905 | 0.5987 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                      | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K   |
|--------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|-----------------|
| Opening Type 2 (Uw = 1.30)                                   |                         |                            | 15.5500                   | 1.2357                        | 19.2158      |                                | (27)            |
| Opening Type 3                                               |                         |                            | 2.1200                    | 1.5000                        | 3.1800       |                                | (26a)           |
| Heat Loss Floor 1                                            |                         |                            | 40.6900                   | 0.1100                        | 4.4759       | 75.0000                        | 3051.7500 (28a) |
| Brick Faced                                                  | 93.9300                 | 17.6700                    | 76.2600                   | 0.2400                        | 18.3024      | 60.0000                        | 4575.6000 (29a) |
| Plane Roof                                                   | 41.0600                 |                            | 41.0600                   | 0.1100                        | 4.5166       | 9.0000                         | 369.5400 (30)   |
| Flat Roof Kitchen/Diner                                      | 2.9200                  |                            | 2.9200                    | 0.1200                        | 0.3504       | 0.0000                         | 0.0000 (30)     |
| Total net area of external elements Aum (A, m <sup>2</sup> ) |                         |                            | 178.6000                  |                               |              |                                | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                          |                         |                            | (26)...(30) + (32) =      | 50.0411                       |              |                                | (33)            |
| Party Wall 1                                                 |                         |                            | 41.3500                   | 0.0000                        | 0.0000       | 45.0000                        | 1860.7500 (32)  |
| Internal Wall 2                                              |                         |                            | 163.5200                  |                               |              | 9.0000                         | 1471.6800 (32c) |
| Internal Floor 1                                             |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32d)  |
| Internal Ceiling 1                                           |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32e)  |

Heat capacity Cm = Sum(A x k)  
Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K  
Thermal bridges (Sum(L x Psi) calculated using Appendix K)  
Total fabric heat loss

|                                                                     |          |          |          |          |          |          |          |          |          |          |          |               |
|---------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |          |          |          |          |          |          |          |          |          |          |          |               |
| (38)m                                                               | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
| Heat transfer coeff                                                 | 41.7382  | 41.4325  | 41.1328  | 39.7254  | 39.4621  | 38.2362  | 38.2362  | 38.0092  | 38.7084  | 39.4621  | 39.9948  | 40.5517 (38)  |
| Average = Sum(39)m / 12 =                                           | 104.4008 | 104.0951 | 103.7954 | 102.3880 | 102.1247 | 100.8988 | 100.8988 | 100.6718 | 101.3710 | 102.1247 | 102.6574 | 103.2143 (39) |

|               |        |        |        |        |        |        |        |        |        |        |        |             |
|---------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|-------------|
| HLP           | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec         |
| HLP (average) | 1.2843 | 1.2805 | 1.2769 | 1.2595 | 1.2563 | 1.2412 | 1.2412 | 1.2384 | 1.2470 | 1.2563 | 1.2629 | 1.2697 (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                        |          |          |          |          |          |         |         |          |          |          |          | 2.4869 (42)    |
| Average daily hot water use (litres/day) |          |          |          |          |          |         |         |          |          |          |          | 93.2634 (43)   |
| Daily hot water use                      | Jan      | Feb      | Mar      | Apr      | May      | Jun     | Jul     | Aug      | Sep      | Oct      | Nov      | Dec            |
| Energy conte                             | 102.5898 | 98.8593  | 95.1287  | 91.3982  | 87.6676  | 83.9371 | 83.9371 | 87.6676  | 91.3982  | 95.1287  | 98.8593  | 102.5898 (44)  |
| Energy content (annual)                  | 152.1377 | 133.0606 | 137.3066 | 119.7072 | 114.8619 | 99.1171 | 91.8466 | 105.3953 | 106.6541 | 124.2950 | 135.6777 | 147.3372 (45)  |
| Total = Sum(45)m =                       |          |          |          |          |          |         |         |          |          |          |          | 1467.3971 (45) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

### CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

|                                                                 |          |          |          |          |           |           |           |          |          |          |          |                 |
|-----------------------------------------------------------------|----------|----------|----------|----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------------|
| Distribution loss (46)m = 0.15 x (45)m                          | 22.8207  | 19.9591  | 20.5960  | 17.9561  | 17.2293   | 14.8676   | 13.7770   | 15.8093  | 15.9981  | 18.6443  | 20.3517  | 22.1006 (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                    | 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                                                      | 14.1217  | 12.7410  | 14.0700  | 13.5754  | 13.9982   | 13.5125   | 13.9416   | 13.9783  | 13.5468  | 14.0403  | 13.6347  | 14.1102 (61)    |
| Total heat required for water heating calculated for each month | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602  | 112.6296  | 105.7882  | 119.3736 | 120.2008 | 138.3354 | 149.3124 | 161.4474 (62)   |
| Aperture area of solar collector                                |          |          |          |          |           |           |           |          |          |          |          | 3.0000 (H1)     |
| Zero-loss collector efficiency                                  |          |          |          |          |           |           |           |          |          |          |          | 0.7000 (H2)     |
| Collector heat loss coefficient                                 |          |          |          |          |           |           |           |          |          |          |          | 1.8000 (H3)     |
| Collector 2nd order heat loss coefficient                       |          |          |          |          |           |           |           |          |          |          |          | 0.0050 (H3a)    |
| Collector effective heat loss coefficient                       |          |          |          |          |           |           |           |          |          |          |          | 1.8063 (H3b)    |
| Collector performance ratio                                     |          |          |          |          |           |           |           |          |          |          |          | 2.5804 (H4)     |
| Annual solar radiation per m2                                   |          |          |          |          |           |           |           |          |          |          |          | 1079.5246 (H5)  |
| Overshading factor                                              |          |          |          |          |           |           |           |          |          |          |          | 0.8000 (H6)     |
| Solar energy available                                          |          |          |          |          |           |           |           |          |          |          |          | 1813.6014 (H7)  |
| Adjustment factor for showers                                   |          |          |          |          |           |           |           |          |          |          |          | 1.0000 (H7a)    |
| Solar-to-load ratio                                             |          |          |          |          |           |           |           |          |          |          |          | 1.2359 (H8)     |
| Utilisation factor                                              |          |          |          |          |           |           |           |          |          |          |          | 0.5547 (H9)     |
| Collector performance factor                                    |          |          |          |          |           |           |           |          |          |          |          | 0.8793 (H10)    |
| Dedicated solar storage volume                                  |          |          |          |          |           |           |           |          |          |          |          | 75.0000 (H11)   |
| Effective solar volume                                          |          |          |          |          |           |           |           |          |          |          |          | 75.0000 (H13)   |
| Daily hot water demand                                          |          |          |          |          |           |           |           |          |          |          |          | 93.2634 (H14)   |
| Volume ratio Veff/V                                             |          |          |          |          |           |           |           |          |          |          |          | 0.8042 (H15)    |
| Solar storage volume factor                                     |          |          |          |          |           |           |           |          |          |          |          | 0.9564 (H16)    |
| Solar input                                                     | -24.5348 | -40.9415 | -69.7280 | -93.4492 | -115.4487 | -113.5044 | -112.0044 | -97.8588 | -76.6431 | -52.3382 | -29.1018 | -846.0842 (H17) |
| Solar input (sum of months) = Sum(63)m =                        |          |          |          |          |           |           |           |          |          |          |          | -846.0842 (63)  |
| Output from w/h                                                 | 141.7246 | 104.8601 | 81.6487  | 39.8334  | 13.4115   | 0.0000    | 0.0000    | 21.5148  | 43.5577  | 85.9971  | 120.2107 | 140.9160 (64)   |
| Total per year (kWh/year) = Sum(64)m =                          |          |          |          |          |           |           |           |          |          |          |          | 793.6747 (64)   |
| Heat gains from water heating, kWh/month                        | 54.1162  | 47.4279  | 49.1720  | 43.1965  | 41.6912   | 36.3346   | 34.0244   | 38.5385  | 38.8492  | 44.8382  | 48.5215  | 52.5172 (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                                                                               | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 50.1153  | 44.5120  | 36.1996  | 27.4054  | 20.4859  | 17.2950  | 18.6879  | 24.2912  | 32.6036  | 41.3978  | 48.3173  | 51.5082  | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 331.5156 | 334.9557 | 326.2868 | 307.8317 | 284.5354 | 262.6402 | 248.0128 | 244.5727 | 253.2417 | 271.6968 | 294.9931 | 316.8883 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | (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)                                 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | (71) |
| Water heating gains (Table 5)                                                       | 72.7368  | 70.5772  | 66.0913  | 59.9951  | 56.0365  | 50.4647  | 45.7317  | 51.7991  | 53.9572  | 60.2664  | 67.3910  | 70.5876  | (72) |
| Total internal gains                                                                | 559.5136 | 555.1907 | 533.7235 | 500.3780 | 466.2036 | 435.5457 | 417.5782 | 425.8089 | 444.9483 | 478.5068 | 515.8472 | 544.1299 | (73) |

#### 6. Solar gains

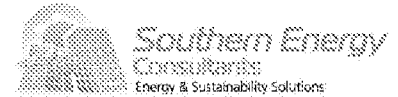
| [Jan]       |          |          |          | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 |           | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W   |          |               |
|-------------|----------|----------|----------|------------|--------------------------------|-----------|-----------------------------------|------------------------------------|------------------------------|--------------|----------|---------------|
| Northeast   |          |          |          | 0.7800     | 11.2829                        |           | 0.4500                            | 0.0000                             | 0.7700                       | 3.0494 (75)  |          |               |
| Southeast   |          |          |          | 5.7000     | 36.7938                        |           | 0.4500                            | 0.0000                             | 0.7700                       | 72.6697 (77) |          |               |
| Southwest   |          |          |          | 0.7800     | 36.7938                        |           | 0.4500                            | 0.0000                             | 0.7700                       | 9.9443 (79)  |          |               |
| Northwest   |          |          |          | 8.2900     | 11.2829                        |           | 0.4500                            | 0.0000                             | 0.7700                       | 32.4101 (81) |          |               |
|             |          |          |          |            |                                |           |                                   |                                    |                              |              |          |               |
| Solar gains | 118.0734 | 212.9010 | 322.5855 | 452.1376   | 554.2952                       | 571.3404  | 542.0716                          | 462.6387                           | 366.9423                     | 243.7362     | 143.5697 | 99.6583 (83)  |
| Total gains | 677.5870 | 768.0917 | 856.3090 | 952.5156   | 1020.4988                      | 1006.8861 | 959.6498                          | 888.4475                           | 811.8905                     | 722.2430     | 659.4169 | 643.7882 (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                                                                         | 34.0767 | 34.1768 | 34.2754 | 34.7466 | 34.8362 | 35.2594 | 35.2594 | 35.3389 | 35.0952                   | 34.8362 | 34.6554 | 34.4684      |
| alpha                                                                       | 3.2718  | 3.2785  | 3.2850  | 3.3164  | 3.3224  | 3.3506  | 3.3506  | 3.3559  | 3.3397                    | 3.3224  | 3.3104  | 3.2979       |
| util living area                                                            | 0.9717  | 0.9565  | 0.9258  | 0.8575  | 0.7403  | 0.5806  | 0.4432  | 0.4915  | 0.7093                    | 0.8905  | 0.9567  | 0.9757 (86)  |
| MIT                                                                         | 19.2878 | 19.5133 | 19.8739 | 20.3298 | 20.6913 | 20.9025 | 20.9702 | 20.9578 | 20.8031                   | 20.3342 | 19.7370 | 19.2486 (87) |
| Th 2                                                                        | 19.8532 | 19.8561 | 19.8590 | 19.8727 | 19.8752 | 19.8872 | 19.8872 | 19.8894 | 19.8826                   | 19.8752 | 19.8700 | 19.8646 (88) |
| util rest of house                                                          | 0.9658  | 0.9475  | 0.9101  | 0.8273  | 0.6865  | 0.4982  | 0.3391  | 0.3846  | 0.6326                    | 0.8602  | 0.9461  | 0.9706 (89)  |
| MIT 2                                                                       | 17.6127 | 17.9380 | 18.4528 | 19.0925 | 19.5625 | 19.8127 | 19.8726 | 19.8669 | 19.7133                   | 19.1166 | 18.2736 | 17.5636 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.2175 (91)  |
| MIT                                                                         | 17.9770 | 18.2806 | 18.7619 | 19.3616 | 19.8080 | 20.0497 | 20.1113 | 20.1042 | 19.9503                   | 19.3815 | 18.5918 | 17.9300 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500      |
| adjusted MIT                                                                | 17.8270 | 18.1306 | 18.6119 | 19.2116 | 19.6580 | 19.8997 | 19.9613 | 19.9542 | 19.8003                   | 19.2315 | 18.4418 | 17.7800 (93) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### Calculation of Energy Ratings for Improved Dwelling 09 Jan 2014

#### 8. Space heating requirement

|                      | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov          | Dec       |       |
|----------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|--------------|-----------|-------|
| Utilisation          | 0.9508    | 0.9289    | 0.8881    | 0.8062    | 0.6749   | 0.4992   | 0.3463   | 0.3911   | 0.6263   | 0.8386   | 0.9277       | 0.9569    | (94)  |
| Useful gains         | 644.2518  | 713.5180  | 760.4776  | 767.9102  | 688.6852 | 502.6043 | 332.3578 | 347.5109 | 508.4852 | 605.6723 | 611.7637     | 616.0582  | (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     | 1412.2335 | 1377.2434 | 1257.1590 | 1055.7840 | 812.7090 | 534.7370 | 339.1532 | 357.8058 | 577.8467 | 881.4847 | 1164.3244    | 1401.6548 | (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    | 571.3784  | 446.0235  | 369.5309  | 207.2692  | 92.2738  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 205.2044 | 397.8437     | 584.4839  | (98)  |
| Space heating        |           |           |           |           |          |          |          |          |          |          |              | 2874.0077 | (98)  |
| Space heating per m2 |           |           |           |           |          |          |          |          |          |          | (98) / (4) = | 35.3550   | (99)  |

#### 8c. Space cooling requirement

Not applicable

#### 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                                             |          |          |          |          |          |         |         |         |         |           |          |           | 3175.6991 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun     | Jul     | Aug     | Sep     | Oct       | Nov      | Dec       |                 |
| Space heating requirement                                             | 571.3784 | 446.0235 | 369.5309 | 207.2692 | 92.2738  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 205.2044  | 397.8437 | 584.4839  | (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)                              | 631.3573 | 492.8436 | 408.3215 | 229.0267 | 101.9600 | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 226.7452  | 439.6063 | 645.8385  | (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                                             | 141.7246 | 104.8601 | 81.6487  | 39.8334  | 13.4115  | 0.0000  | 0.0000  | 21.5148 | 43.5577 | 85.9971   | 120.2107 | 140.9160  | (64)            |
| Efficiency of water heater                                            | 89.8455  | 89.8729  | 89.9036  | 89.9684  | 90.0810  | 87.3000 | 87.3000 | 87.3000 | 87.3000 | 89.5308   | 89.7367  | 89.8601   | (217)           |
| Fuel for water heating, kWh/month                                     | 157.7426 | 116.6760 | 90.8180  | 44.2749  | 14.8883  | 0.0000  | 0.0000  | 24.6447 | 49.8943 | 96.0531   | 133.9593 | 156.8170  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |         |         |         |         |           |          | 885.7681  | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |         |         |         |         |           |          | 3175.6991 | (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)  |
| pump for solar water heating                                          |          |          |          |          |          |         |         |         |         |           |          |           | 50.0000 (230g)  |
| Total electricity for the above, kWh/year                             |          |          |          |          |          |         |         |         |         |           |          |           | 125.0000 (231)  |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |          |         |         |         |         |           |          |           | 354.0209 (232)  |
| Energy saving/generation technologies (Appendices M, N and Q)         |          |          |          |          |          |         |         |         |         |           |          |           |                 |
| PV Unit 0 (0.80 * 0.75 * 1029 * 0.80) =                               |          |          |          |          |          |         |         |         |         | -494.0096 |          | -494.0096 | (233)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |         |         |         |         |           |          | 4046.4785 | (238)           |

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

|                                       | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |       |
|---------------------------------------|---------------|------------------|------------------|-------|
| Space heating - main system 1         | 3175.6991     | 3.4800           | 110.5143         | (240) |
| Space heating - secondary             | 0.0000        | 0.0000           | 0.0000           | (242) |
| Water heating (other fuel)            | 885.7681      | 3.4800           | 30.8247          | (247) |
| Pumps and fans for heating            | 75.0000       | 13.1900          | 9.8925           | (249) |
| Pump for solar water heating          | 50.0000       | 13.1900          | 6.5950           | (249) |
| Energy for lighting                   | 354.0209      | 13.1900          | 46.6954          | (250) |
| Additional standing charges           |               |                  | 120.0000         | (251) |
| Energy saving/generation technologies |               |                  |                  |       |
| PV Unit                               | -494.0096     | 13.1900          | -65.1599         | (252) |
| Total energy cost                     |               |                  | 259.3620         | (255) |

#### 11a. SAP rating - Individual heating systems

|                                  |                                  |              |
|----------------------------------|----------------------------------|--------------|
| Energy cost deflator (Table 12): |                                  | 0.4200 (256) |
| Energy cost factor (ECF)         | [(255) x (256)] / [(4) + 45.0] = | 0.8626 (257) |
| SAP value                        |                                  | 87.9674      |
| SAP rating (Section 12)          |                                  | 88 (258)     |
| SAP band                         |                                  | B            |

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

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

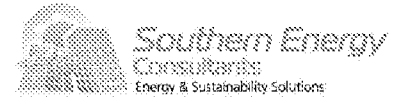


### CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

|                                       | Energy<br>kWh/year | Emission factor<br>kg CO2/kWh | Emissions<br>kg CO2/year |
|---------------------------------------|--------------------|-------------------------------|--------------------------|
| Space heating - main system 1         | 3175.6991          | 0.2160                        | 685.9510 (261)           |
| Space heating - secondary             | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)            | 885.7681           | 0.2160                        | 191.3259 (264)           |
| Space and water heating               |                    |                               | 877.2769 (265)           |
| Pumps and fans                        | 125.0000           | 0.5190                        | 64.8750 (267)            |
| Energy for lighting                   | 354.0209           | 0.5190                        | 183.7368 (268)           |
| Energy saving/generation technologies |                    |                               |                          |
| PV Unit                               | -494.0096          | 0.5190                        | -256.3910 (269)          |
| Total kg/year                         |                    |                               | 869.4978 (272)           |
| CO2 emissions per m2                  |                    |                               | 10.7000 (273)            |
| EI value                              |                    |                               | 90.7742                  |
| EI rating                             |                    |                               | 91 (274)                 |
| EI band                               |                    |                               | B                        |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
 CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 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                                           | 40.6900 (1b)              | x 2.4000 (2b)                   | = 97.6560 (1b) - (3b)       |
| First floor                                            | 40.6000 (1c)              | x 2.6500 (2c)                   | = 107.5900 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 81.2900                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 205.2460 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other | total | m3 per hour                             |
|---------------------------------------------------------------------------|-----------------|----------------------|-------|-------|-----------------------------------------|
| Number of chimneys                                                        | 0               | +                    | 0     | =     | 0 * 40 = 0.0000 (6a)                    |
| Number of open flues                                                      | 0               | +                    | 0     | =     | 0 * 20 = 0.0000 (6b)                    |
| Number of intermittent fans                                               |                 |                      |       |       | 4 * 10 = 40.0000 (7a)                   |
| Number of passive vents                                                   |                 |                      |       |       | 0 * 10 = 0.0000 (7b)                    |
| Number of flueless gas fires                                              |                 |                      |       |       | 0 * 40 = 0.0000 (7c)                    |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = |                 |                      |       |       | 40.0000 / (5) = 0.1949 (8)              |
| Pressure test                                                             |                 |                      |       |       | Yes                                     |
| Measured/design AP50                                                      |                 |                      |       |       | 5.0000                                  |
| Infiltration rate                                                         |                 |                      |       |       | 0.4449 (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) = 0.3782 (21)        |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.6000 | 5.1000 | 4.8000 | 4.5000 | 4.7000 | 4.2000 | 4.4000 | 4.2000 | 4.4000 | 4.8000 | 4.9000 | 5.1000 (22)  |
| Wind factor     | 1.4000 | 1.2750 | 1.2000 | 1.1250 | 1.1750 | 1.0500 | 1.1000 | 1.0500 | 1.1000 | 1.2000 | 1.2250 | 1.2750 (22a) |
| Adj infilt rate | 0.5294 | 0.4821 | 0.4538 | 0.4254 | 0.4443 | 0.3971 | 0.4160 | 0.3971 | 0.4160 | 0.4538 | 0.4632 | 0.4821 (22b) |
| Effective ac    | 0.6401 | 0.6162 | 0.6030 | 0.5905 | 0.5987 | 0.5788 | 0.5865 | 0.5788 | 0.5865 | 0.6030 | 0.6073 | 0.6162 (25)  |

#### 3. Heat losses and heat loss parameter

| Element                                                      | Gross<br>m <sup>2</sup> | Openings<br>m <sup>2</sup> | NetArea<br>m <sup>2</sup> | U-value<br>W/m <sup>2</sup> K | A x U<br>W/K | K-value<br>kJ/m <sup>2</sup> K | A x K<br>kJ/K   |
|--------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|-----------------|
| Opening Type 2 (Uw = 1.30)                                   |                         |                            | 15.5500                   | 1.2357                        | 19.2158      |                                | (27)            |
| Opening Type 3                                               |                         |                            | 2.1200                    | 1.5000                        | 3.1800       |                                | (26a)           |
| Heat Loss Floor 1                                            |                         |                            | 40.6900                   | 0.1100                        | 4.4759       | 75.0000                        | 3051.7500 (28a) |
| Brick Faced                                                  | 93.9300                 | 17.6700                    | 76.2600                   | 0.2400                        | 18.3024      | 60.0000                        | 4575.6000 (29a) |
| Plane Roof                                                   | 41.0600                 |                            | 41.0600                   | 0.1100                        | 4.5166       | 9.0000                         | 369.5400 (30)   |
| Flat Roof Kitchen/Diner                                      | 2.9200                  |                            | 2.9200                    | 0.1200                        | 0.3504       | 0.0000                         | 0.0000 (30)     |
| Total net area of external elements Aum (A, m <sup>2</sup> ) |                         |                            | 178.6000                  |                               |              |                                | (31)            |
| Fabric heat loss, W/K = Sum (A x U)                          |                         |                            |                           | (26)...(30) + (32) =          | 50.0411      |                                | (33)            |
| Party Wall 1                                                 |                         |                            | 41.3500                   | 0.0000                        | 0.0000       | 45.0000                        | 1860.7500 (32)  |
| Internal Wall 2                                              |                         |                            | 163.5200                  |                               |              | 9.0000                         | 1471.6800 (32c) |
| Internal Floor 1                                             |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32d)  |
| Internal Ceiling 1                                           |                         |                            | 41.0600                   |                               |              | 18.0000                        | 739.0800 (32e)  |

Heat capacity Cm = Sum(A x k)  
 Thermal mass parameter (TMP = Cm / TFA) in kJ/m<sup>2</sup>K  
 Thermal bridges (Sum(L x Psi) calculated using Appendix K)  
 Total fabric heat loss  
 (28)...(30) + (32) + (32a)...(32e) = 12807.4800 (34)  
 157.5530 (35)  
 12.6215 (36)  
 (33) + (36) = 62.6626 (37)

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

|                           | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec           |
|---------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| (38)m                     | 43.3575  | 41.7382  | 40.8392  | 39.9948  | 40.5517  | 39.2048  | 39.7254  | 39.2048  | 39.7254  | 40.8392  | 41.1328  | 41.7382 (38)  |
| Heat transfer coeff       | 106.0201 | 104.4008 | 103.5018 | 102.6574 | 103.2143 | 101.8674 | 102.3880 | 101.8674 | 102.3880 | 103.5018 | 103.7954 | 104.4008 (39) |
| Average = Sum(39)m / 12 = |          |          |          |          |          |          |          |          |          |          |          | 103.3336 (39) |
| HLP                       | 1.3042   | 1.2843   | 1.2732   | 1.2629   | 1.2697   | 1.2531   | 1.2595   | 1.2531   | 1.2595   | 1.2732   | 1.2769   | 1.2843 (40)   |
| HLP (average)             |          |          |          |          |          |          |          |          |          |          |          | 1.2712 (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                        |          |          |          |          |          |         |         |          |          |                    |          | 2.4869 (42)    |
| Average daily hot water use (litres/day) |          |          |          |          |          |         |         |          |          |                    |          | 93.2634 (43)   |
| Jan                                      | Feb      | Mar      | Apr      | May      | Jun      | Jul     | Aug     | Sep      | Oct      | Nov                | Dec      |                |
| Daily hot water use                      | 102.5898 | 98.8593  | 95.1287  | 91.3982  | 87.6676  | 83.9371 | 83.9371 | 87.6676  | 91.3982  | 95.1287            | 98.8593  | 102.5898 (44)  |
| Energy conte                             | 152.1377 | 133.0606 | 137.3066 | 119.7072 | 114.8619 | 99.1171 | 91.8466 | 105.3953 | 106.6541 | 124.2950           | 135.6777 | 147.3372 (45)  |
| Energy content (annual)                  |          |          |          |          |          |         |         |          |          | Total = Sum(45)m = |          | 1467.3971 (45) |

Regs Region: England

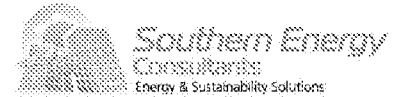
Elmhurst Energy Systems

SAP2012 Calculator (Design

System) version 4.14r19

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

|                                                                 |          |          |          |          |           |           |           |           |          |          |          |                 |
|-----------------------------------------------------------------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|----------|----------|----------|-----------------|
| Distribution loss (46)m = 0.15 x (45)m                          | 22.8207  | 19.9591  | 20.5960  | 17.9561  | 17.2293   | 14.8676   | 13.7770   | 15.8093   | 15.9981  | 18.6443  | 20.3517  | 22.1006 (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                    | 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                                                      | 14.1217  | 12.7410  | 14.0700  | 13.5754  | 13.9982   | 13.5125   | 13.9416   | 13.9783   | 13.5468  | 14.0403  | 13.6347  | 14.1102 (61)    |
| Total heat required for water heating calculated for each month | 166.2594 | 145.8016 | 151.3767 | 133.2826 | 128.8602  | 112.6296  | 105.7882  | 119.3736  | 120.2008 | 138.3354 | 149.3124 | 161.4474 (62)   |
| Aperture area of solar collector                                |          |          |          |          |           |           |           |           |          |          |          | 3.0000 (H1)     |
| Zero-loss collector efficiency                                  |          |          |          |          |           |           |           |           |          |          |          | 0.7000 (H2)     |
| Collector heat loss coefficient                                 |          |          |          |          |           |           |           |           |          |          |          | 1.8000 (H3)     |
| Collector 2nd order heat loss coefficient                       |          |          |          |          |           |           |           |           |          |          |          | 0.0050 (H3a)    |
| Collector effective heat loss coefficient                       |          |          |          |          |           |           |           |           |          |          |          | 1.8063 (H3b)    |
| Collector performance ratio                                     |          |          |          |          |           |           |           |           |          |          |          | 2.5804 (H4)     |
| Annual solar radiation per m2                                   |          |          |          |          |           |           |           |           |          |          |          | 1306.9326 (H5)  |
| Overshading factor                                              |          |          |          |          |           |           |           |           |          |          |          | 0.8000 (H6)     |
| Solar energy available                                          |          |          |          |          |           |           |           |           |          |          |          | 2195.6468 (H7)  |
| Adjustment factor for showers                                   |          |          |          |          |           |           |           |           |          |          |          | 1.0000 (H7a)    |
| Solar-to-load ratio                                             |          |          |          |          |           |           |           |           |          |          |          | 1.4963 (H8)     |
| Utilisation factor                                              |          |          |          |          |           |           |           |           |          |          |          | 0.4874 (H9)     |
| Collector performance factor                                    |          |          |          |          |           |           |           |           |          |          |          | 0.8793 (H10)    |
| Dedicated solar storage volume                                  |          |          |          |          |           |           |           |           |          |          |          | 75.0000 (H11)   |
| Effective solar volume                                          |          |          |          |          |           |           |           |           |          |          |          | 75.0000 (H13)   |
| Daily hot water demand                                          |          |          |          |          |           |           |           |           |          |          |          | 93.2634 (H14)   |
| Volume ratio Veff/V                                             |          |          |          |          |           |           |           |           |          |          |          | 0.8042 (H15)    |
| Solar storage volume factor                                     |          |          |          |          |           |           |           |           |          |          |          | 0.9564 (H16)    |
| Solar input                                                     | -29.4481 | -41.0536 | -69.8957 | -97.3806 | -116.4388 | -123.0076 | -120.5900 | -105.7653 | -82.5709 | -56.4806 | -33.4961 | -900.0259 (H17) |
| Solar input (sum of months) = Sum(63)m =                        |          |          |          |          |           |           |           |           |          |          |          | -900.0259 (63)  |
| Output from w/h                                                 | 136.8112 | 104.7479 | 81.4809  | 35.9020  | 12.4214   | 0.0000    | 0.0000    | 13.6084   | 37.6299  | 81.8548  | 115.8164 | 137.5488 (64)   |
| Total per year (kWh/year) = Sum(64)m =                          |          |          |          |          |           |           |           |           |          |          |          | 757.8217 (64)   |
| Heat gains from water heating, kWh/month                        | 54.1162  | 47.4279  | 49.1720  | 43.1965  | 41.6912   | 36.3346   | 34.0244   | 38.5385   | 38.8492  | 44.8382  | 48.5215  | 52.5172 (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                                                                               | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | 149.2129 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 50.1153  | 44.5120  | 36.1996  | 27.4054  | 20.4859  | 17.2950  | 18.6879  | 24.2912  | 32.6036  | 41.3978  | 48.3173  | 51.5082  | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 331.5156 | 334.9557 | 326.2868 | 307.8317 | 284.5354 | 262.6402 | 248.0128 | 244.5727 | 253.2417 | 271.6968 | 294.9931 | 316.8883 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | 52.4082  | (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)                                 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | -99.4753 | (71) |
| Water heating gains (Table 5)                                                       | 72.7368  | 70.5772  | 66.0913  | 59.9951  | 56.0365  | 50.4647  | 45.7317  | 51.7991  | 53.9572  | 60.2664  | 67.3910  | 70.5876  | (72) |
| Total internal gains                                                                | 559.5136 | 555.1907 | 533.7235 | 500.3780 | 466.2036 | 435.5457 | 417.5782 | 425.8089 | 444.9483 | 478.5068 | 515.8472 | 544.1299 | (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 | 0.7800     | 15.8975                        | 0.4500                            | 0.0000                             | 0.7700                       | 4.2966 (75)  |
| Southeast | 5.7000     | 48.9171                        | 0.4500                            | 0.0000                             | 0.7700                       | 96.6137 (77) |
| Southwest | 0.7800     | 48.9171                        | 0.4500                            | 0.0000                             | 0.7700                       | 13.2208 (79) |
| Northwest | 8.2900     | 15.8975                        | 0.4500                            | 0.0000                             | 0.7700                       | 45.6653 (81) |

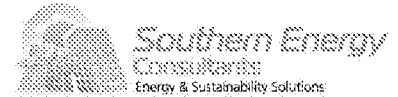
|             |          |          |          |           |           |           |           |          |          |          |          |               |
|-------------|----------|----------|----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|---------------|
| Solar gains | 159.7964 | 241.5158 | 368.1132 | 539.6873  | 642.0082  | 711.2739  | 670.3929  | 573.5583 | 451.2689 | 298.2153 | 186.4811 | 130.7072 (83) |
| Total gains | 719.3100 | 796.7065 | 901.8367 | 1040.0654 | 1108.2118 | 1146.8195 | 1087.9711 | 999.3671 | 896.2172 | 776.7221 | 702.3283 | 674.8370 (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                                                                         | 33.5562 | 34.0767 | 34.3727 | 34.6554 | 34.4684 | 34.9242 | 34.7466 | 34.9242 | 34.7466                   | 34.3727 | 34.2754 | 34.0767      |
| alpha                                                                       | 3.2371  | 3.2718  | 3.2915  | 3.3104  | 3.2979  | 3.3283  | 3.3164  | 3.3283  | 3.3164                    | 3.2915  | 3.2850  | 3.2718       |
| util living area                                                            | 0.9580  | 0.9430  | 0.9010  | 0.8049  | 0.6502  | 0.4571  | 0.3238  | 0.3304  | 0.5625                    | 0.8123  | 0.9274  | 0.9628 (86)  |
| MIT                                                                         | 19.5515 | 19.7143 | 20.0747 | 20.5041 | 20.8172 | 20.9588 | 20.9903 | 20.9905 | 20.9226                   | 20.6062 | 20.0605 | 19.5540 (87) |
| Th 2                                                                        | 19.8375 | 19.8532 | 19.8619 | 19.8700 | 19.8646 | 19.8777 | 19.8727 | 19.8777 | 19.8727                   | 19.8619 | 19.8590 | 19.8532 (88) |
| util rest of house                                                          | 0.9485  | 0.9307  | 0.8799  | 0.7657  | 0.5839  | 0.3704  | 0.2221  | 0.2208  | 0.4639                    | 0.7596  | 0.9082  | 0.9542 (89)  |
| MIT 2                                                                       | 17.9839 | 18.2243 | 18.7356 | 19.3184 | 19.6982 | 19.8522 | 19.8696 | 19.8750 | 19.8221                   | 19.4632 | 18.7261 | 17.9987 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.2175 (91)  |
| MIT                                                                         | 18.3249 | 18.5483 | 19.0268 | 19.5762 | 19.9416 | 20.0929 | 20.1134 | 20.1176 | 20.0615                   | 19.7118 | 19.0164 | 18.3370 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500      |
| adjusted MIT                                                                | 18.1749 | 18.3983 | 18.8768 | 19.4262 | 19.7916 | 19.9429 | 19.9634 | 19.9676 | 19.9115                   | 19.5618 | 18.8664 | 18.1870 (93) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### Calculation of EPC Costs, Emissions and Primary Energy for Improved Dwelling 09 Jan 2014

#### 8. Space heating requirement

|                      | Jan       | Feb       | Mar       | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct          | Nov       | Dec       |       |
|----------------------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|--------------|-----------|-----------|-------|
| Utilisation          | 0.9300    | 0.9101    | 0.8573    | 0.7480   | 0.5793   | 0.3756   | 0.2304   | 0.2298   | 0.4675   | 0.7432       | 0.8864    | 0.9368    | (94)  |
| Useful gains         | 668.9227  | 725.0949  | 773.1008  | 777.9556 | 641.9664 | 430.8004 | 250.6962 | 229.6399 | 418.9899 | 577.2239     | 622.5570  | 632.1969  | (95)  |
| Ext temp.            | 5.8000    | 6.0000    | 7.5000    | 9.8000   | 12.9000  | 15.6000  | 17.5000  | 17.7000  | 15.6000  | 12.5000      | 9.0000    | 6.0000    | (96)  |
| Heat loss rate W     | 1311.9848 | 1294.3975 | 1177.5234 | 988.2043 | 711.3071 | 442.3988 | 252.2190 | 230.9984 | 441.4415 | 730.9136     | 1024.0839 | 1272.3297 | (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    | 478.4382  | 382.5713  | 300.8905  | 151.3790 | 51.5894  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 114.3451     | 289.0994  | 476.2588  | (98)  |
| Space heating        |           |           |           |          |          |          |          |          |          |              |           | 2244.5717 | (98)  |
| Space heating per m2 |           |           |           |          |          |          |          |          |          | (98) / (4) = |           | 27.6119   | (99)  |

#### 8c. Space cooling requirement

Not applicable

#### 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                                             |          |          |          |          |         |         |         |         |         |           |          |           | 2480.1898 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May     | Jun     | Jul     | Aug     | Sep     | Oct       | Nov      | Dec       |                 |
| Space heating requirement                                             | 478.4382 | 382.5713 | 300.8905 | 151.3790 | 51.5894 | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 114.3451  | 289.0994 | 476.2588  | (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)                              | 528.6610 | 422.7307 | 332.4757 | 167.2697 | 57.0049 | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 126.3482  | 319.4468 | 526.2528  | (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                                             | 136.8112 | 104.7479 | 81.4809  | 35.9020  | 12.4214 | 0.0000  | 0.0000  | 13.6084 | 37.6299 | 81.8548   | 115.8164 | 137.5488  | (64)            |
| Efficiency of water heater                                            | 89.7683  | 89.7925  | 89.7986  | 89.8685  | 89.8608 | 87.3000 | 87.3000 | 87.3000 | 87.3000 | 89.1369   | 89.5610  | 89.7627   | (217)           |
| Fuel for water heating, kWh/month                                     | 152.4048 | 116.6555 | 90.7374  | 39.9495  | 13.8229 | 0.0000  | 0.0000  | 15.5880 | 43.1042 | 91.8304   | 129.3156 | 153.2361  | (219)           |
| Water heating fuel used                                               |          |          |          |          |         |         |         |         |         |           |          | 846.6445  | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |         |         |         |         |         |           |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |         |         |         |         |         |           |          | 2480.1898 | (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)  |
| pump for solar water heating                                          |          |          |          |          |         |         |         |         |         |           |          |           | 50.0000 (230g)  |
| Total electricity for the above, kWh/year                             |          |          |          |          |         |         |         |         |         |           |          |           | 125.0000 (231)  |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |         |         |         |         |         |           |          |           | 354.0209 (232)  |
| Energy saving/generation technologies (Appendices M, N and Q)         |          |          |          |          |         |         |         |         |         |           |          |           |                 |
| PV Unit 0 (0.80 * 0.75 * 1252 * 0.80) =                               |          |          |          |          |         |         |         |         |         | -600.8139 |          | -600.8139 | (233)           |
| Total delivered energy for all uses                                   |          |          |          |          |         |         |         |         |         |           |          | 3205.0412 | (238)           |

#### 10a. Fuel costs - using BEDF prices (491)

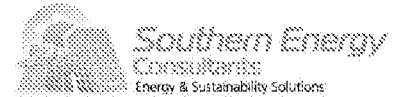
|                                       | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |
|---------------------------------------|---------------|------------------|------------------|
| Space heating - main system 1         | 2480.1898     | 3.6300           | 90.0309 (240)    |
| Space heating - secondary             | 0.0000        | 0.0000           | 0.0000 (242)     |
| Water heating (other fuel)            | 846.6445      | 3.6300           | 30.7332 (247)    |
| Pumps and fans for heating            | 75.0000       | 19.4400          | 14.5800 (249)    |
| Pump for solar water heating          | 50.0000       | 19.4400          | 9.7200 (249)     |
| Energy for lighting                   | 354.0209      | 19.4400          | 68.8217 (250)    |
| Additional standing charges           |               |                  | 95.0000 (251)    |
| Energy saving/generation technologies |               |                  |                  |
| PV Unit                               | -600.8139     | 19.4400          | -116.7982 (252)  |
| Total energy cost                     |               |                  | 192.0875 (255)   |

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

|                                       | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |
|---------------------------------------|-----------------|----------------------------|-----------------------|
| Space heating - main system 1         | 2480.1898       | 0.2160                     | 535.7210 (261)        |
| Space heating - secondary             | 0.0000          | 0.0000                     | 0.0000 (263)          |
| Water heating (other fuel)            | 846.6445        | 0.2160                     | 182.8752 (264)        |
| Space and water heating               |                 |                            | 718.5962 (265)        |
| Pumps and fans                        | 125.0000        | 0.5190                     | 64.8750 (267)         |
| Energy for lighting                   | 354.0209        | 0.5190                     | 183.7368 (268)        |
| Energy saving/generation technologies |                 |                            |                       |
| PV Unit                               | -600.8139       | 0.5190                     | -311.8224 (269)       |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

Total kg/year 655.3856 (272)

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

|                                       | Energy<br>kWh/year | Primary energy factor<br>kg CO2/kWh | Primary energy<br>kWh/year |
|---------------------------------------|--------------------|-------------------------------------|----------------------------|
| Space heating - main system 1         | 2480.1898          | 1.2200                              | 3025.8315 (261)            |
| Space heating - secondary             | 0.0000             | 0.0000                              | 0.0000 (263)               |
| Water heating (other fuel)            | 846.6445           | 1.2200                              | 1032.9063 (264)            |
| Space and water heating               |                    |                                     | 4058.7378 (265)            |
| Pumps and fans                        | 125.0000           | 3.0700                              | 383.7500 (267)             |
| Energy for lighting                   | 354.0209           | 3.0700                              | 1086.8441 (268)            |
| Energy saving/generation technologies |                    |                                     |                            |
| PV Unit                               | -600.8139          | 3.0700                              | -1844.4987 (269)           |
| Primary energy kWh/year               |                    |                                     | 3684.8332 (272)            |
| Primary energy kWh/m2/year            |                    |                                     | 45.3295 (273)              |

#### SAP 2012 OVERHEATING ASSESSMENT FOR New Build (As Designed) 9.92

##### Overheating Calculation Input Data

|                                           |                                               |
|-------------------------------------------|-----------------------------------------------|
| Dwelling type                             | SemiDetached House                            |
| Number of storeys                         | 2                                             |
| Cross ventilation possible                | Yes                                           |
| SAP Region                                | Thames Valley                                 |
| Front of dwelling faces                   | South East                                    |
| Overshading                               | Average or unknown                            |
| Thermal mass parameter                    | 157.6 (calculated from construction elements) |
| Night ventilation                         | Yes                                           |
| Ventilation rate during hot weather (ach) | 4.00 (Windows half open)                      |

##### Overheating Calculation

|                                          |             |
|------------------------------------------|-------------|
| Summer ventilation heat loss coefficient | 270.92 (P1) |
| Transmission heat loss coefficient       | 62.66 (37)  |
| Summer heat loss coefficient             | 333.59 (P2) |

| Overhangs   | Ratio | Z_overhangs | Overhang type |
|-------------|-------|-------------|---------------|
| Orientation |       |             |               |
| North East  | 0.000 | 1.000       | None          |
| South East  | 0.000 | 1.000       | None          |
| South West  | 0.000 | 1.000       | None          |
| North West  | 0.000 | 1.000       | None          |

| Solar shading | Z_blinds | Solar access | Z_overhangs | Z_summer   |
|---------------|----------|--------------|-------------|------------|
| Orientation   |          |              |             |            |
| North East    | 1.000    | 0.90         | 1.000       | 0.900 (P8) |
| South East    | 1.000    | 0.90         | 1.000       | 0.900 (P8) |
| South West    | 1.000    | 0.90         | 1.000       | 0.900 (P8) |
| North West    | 1.000    | 0.90         | 1.000       | 0.900 (P8) |

| [Jul]      | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | Specific data<br>g<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Shading | Gains<br>W |
|------------|------------|--------------------------------|-----------------------------------|------------------------------------|---------|------------|
| North East | 0.7800     | 98.8453                        | 0.4500                            | 0.0000                             | 0.9000  | 31.2252    |
| South East | 5.7000     | 119.9223                       | 0.4500                            | 0.0000                             | 0.9000  | 276.8407   |
| South West | 0.7800     | 119.9223                       | 0.4500                            | 0.0000                             | 0.9000  | 37.8835    |
| North West | 8.2900     | 98.8453                        | 0.4500                            | 0.0000                             | 0.9000  | 331.8681   |

total: 677.8175

|                                                        | Jun             | Jul    | Aug    |      |
|--------------------------------------------------------|-----------------|--------|--------|------|
| Solar gains                                            | 722             | 678    | 591    | (P4) |
| Internal gains                                         | 433             | 415    | 423    |      |
| Total summer gains                                     | 1155            | 1092   | 1013   | (P5) |
| Summer gain/loss ratio                                 | 3.46            | 3.27   | 3.04   | (P6) |
| Summer external temperature                            | 16.00           | 17.90  | 17.80  |      |
| Thermal mass temperature increment (TMP = 157.6)       | 0.90            | 0.90   | 0.90   |      |
| Threshold temperature                                  | 20.36           | 22.07  | 21.74  | (P7) |
| Likelihood of high internal temperature                | Not significant | Medium | Slight |      |
| Assessment of likelihood of high internal temperature: | Medium          |        |        |      |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



|                                    |                                                                         |               |       |                |            |
|------------------------------------|-------------------------------------------------------------------------|---------------|-------|----------------|------------|
| Property Reference                 | SECH00107                                                               |               |       | Issued on Date | 16/03/2022 |
| Assessment Reference               | 001                                                                     | Prop Type Ref | MA    |                |            |
| Property                           | Plot 107, Pagham, Bognor Regis, West Sussex, PO21                       |               |       |                |            |
| SAP Rating                         | 87 B                                                                    | DEI           | 14.34 | TSE            | 18.25      |
| Environmental                      | 88 B                                                                    | % DER+TER     | 21.41 |                |            |
| CO <sub>2</sub> Emissions (t/year) | 0.97                                                                    | DREE          | 48.60 | TTEE           | 57.42      |
| General Requirements Compliance    | Pass                                                                    | % DREF+TTEE   | 15.37 |                |            |
| Assessor Details                   | Mr. Stephen Smith, Southern Energy Consultants Limited, Tel: [REDACTED] |               |       | Assessor ID    | d168-0001  |
| Client                             | Bellway 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 98 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) 18.25 kgCO<sub>2</sub>/m<sup>2</sup>  
Dwelling Carbon Dioxide Emission Rate (DER) 14.34 kgCO<sub>2</sub>/m<sup>2</sup> OK

#### 1b TFEE and DFEE

Target Fabric Energy Efficiency (TFEE) 57.4 kWh/m<sup>2</sup>/yr  
Dwelling Fabric Energy Efficiency (DFEE) 48.6 kWh/m<sup>2</sup>/yr OK

#### 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         | 0.15 (max. 0.25) | 0.15 (max. 0.70) | OK |
| Roof          | 0.11 (max. 0.20) | 0.11 (max. 0.35) | OK |
| Openings      | 1.31 (max. 2.00) | 1.50 (max. 3.30) | OK |

#### 2a Thermal bridging

Thermal bridging calculated from linear thermal transmittances for each junction

#### 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

Not applicable

#### 9 Summertime temperature

Overheating risk (Thames Valley): Not significant OK

#### Based on:

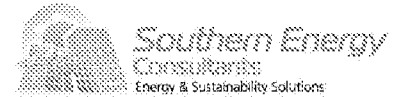
Overshading: Average  
Windows facing North: 13.35 m<sup>2</sup>, No overhang  
Windows facing East: 1.89 m<sup>2</sup>, No overhang  
Windows facing South: 9.95 m<sup>2</sup>, No overhang  
Air change rate: 8.00 ach  
Blinds/curtains: None

#### 10 Key Features

Party wall U-value 0.00 W/m<sup>2</sup>K  
Roof U-value 0.11 W/m<sup>2</sup>K  
Thermal bridging g-value 0.025 W/m<sup>2</sup>K  
Photovoltaic array 0.75 kW

# 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                                           | 51.9700 (1b)              | x 2.3500 (2b)                   | = 122.1295 (1b) - (3b)      |
| First floor                                            | 46.3900 (1c)              | x 2.6500 (2c)                   | = 122.9335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 98.3600                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 245.0630 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|---------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                               |                 |                      |       |                             | 5 * 10 = 50.0000 (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) = |                 |                      |       |                             | 50.0000 / (5) = 0.2040 (8) |
| Pressure test                                                             |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                      |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                         |                 |                      |       |                             | 0.4540 (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) =        | 0.3859 (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 | 0.4921 | 0.4824 | 0.4728 | 0.4245 | 0.4149 | 0.3666 | 0.3666 | 0.3570 | 0.3859 | 0.4149 | 0.4342 | 0.4535 (22b) |
| Effective ac    | 0.6211 | 0.6164 | 0.6118 | 0.5901 | 0.5861 | 0.5672 | 0.5672 | 0.5637 | 0.5745 | 0.5861 | 0.5942 | 0.6028 (25)  |

#### 3. Heat losses and heat loss parameter

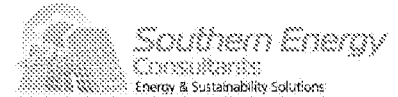
| Element                                                             | Gross<br>m2   | Openings<br>m2 | NetArea<br>m2         | U-value<br>W/m2K | A x U<br>W/K  | K-value<br>kJ/m2K | A x K<br>kJ/K |               |               |               |               |                    |
|---------------------------------------------------------------------|---------------|----------------|-----------------------|------------------|---------------|-------------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| Opening Type 1                                                      |               |                | 1.9500                | 1.5000           | 2.9250        |                   | (26)          |               |               |               |               |                    |
| Opening Type 2 (Uw = 1.30)                                          |               |                | 25.1900               | 1.2357           | 31.1283       |                   | (27)          |               |               |               |               |                    |
| Heat Loss Floor 1                                                   |               |                | 51.9700               | 0.1500           | 7.7955        |                   | (28a)         |               |               |               |               |                    |
| External Wall 1                                                     | 144.8800      | 27.1400        | 117.7400              | 0.2400           | 28.2576       |                   | (29a)         |               |               |               |               |                    |
| External Roof 1                                                     | 51.9700       |                | 51.9700               | 0.1100           | 5.7167        |                   | (30)          |               |               |               |               |                    |
| Total net area of external elements Aum(A, m2)                      |               |                | 248.8200              |                  |               |                   | (31)          |               |               |               |               |                    |
| Fabric heat loss, W/K = Sum (A x U)                                 |               |                | (26)... (30) + (32) = |                  | 75.8231       |                   | (33)          |               |               |               |               |                    |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |               |                |                       |                  |               |                   | 250.0000 (35) |               |               |               |               |                    |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |               |                |                       |                  |               |                   | 6.1647 (36)   |               |               |               |               |                    |
| Total fabric heat loss                                              |               |                |                       |                  |               | (33) + (36) =     | 81.9878 (37)  |               |               |               |               |                    |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |               |                |                       |                  |               |                   |               |               |               |               |               |                    |
| (38)m                                                               | 50.2255       | 49.8453        | 49.4727               | 47.7225          | 47.3950       | 45.8706           | 45.8706       | 45.5883       | 46.4578       | 47.3950       | 48.0575       | 48.7500 (38)       |
| Heat transfer coeff                                                 | 132.2133      | 131.8332       | 131.4605              | 129.7103         | 129.3828      | 127.8584          | 127.8584      | 127.5761      | 128.4456      | 129.3828      | 130.0453      | 130.7378 (39)      |
| Average = Sum(39)m / 12 =                                           |               |                |                       |                  |               |                   |               |               |               |               |               | 129.7087 (39)      |
| HLP                                                                 | Jan<br>1.3442 | Feb<br>1.3403  | Mar<br>1.3365         | Apr<br>1.3187    | May<br>1.3154 | Jun<br>1.2999     | Jul<br>1.2999 | Aug<br>1.2970 | Sep<br>1.3059 | Oct<br>1.3154 | Nov<br>1.3221 | Dec<br>1.3292 (40) |
| HLP (average)                                                       |               |                |                       |                  |               |                   |               |               |               |               |               | 1.3187 (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                            |          |          |          |          |          |          |         |          |          |                    |          | 2.7238 (42)    |
| Average daily hot water use (litres/day)     |          |          |          |          |          |          |         |          |          |                    |          | 98.8906 (43)   |
| Daily hot water use                          | 108.7797 | 104.8241 | 100.8685 | 96.9128  | 92.9572  | 89.0016  | 89.0016 | 92.9572  | 96.9128  | 100.8685           | 104.8241 | 108.7797 (44)  |
| Energy conte                                 | 161.3172 | 141.0890 | 145.5912 | 126.9300 | 121.7923 | 105.0975 | 97.3883 | 111.7545 | 113.0892 | 131.7946           | 143.8641 | 156.2271 (45)  |
| Energy content (annual)                      |          |          |          |          |          |          |         |          |          | Total = Sum(45)m = |          | 1555.9348 (45) |
| Distribution loss (46)m = 0.15 x (45)m       | 24.1976  | 21.1634  | 21.8387  | 19.0395  | 18.2688  | 15.7646  | 14.6082 | 16.7632  | 16.9634  | 19.7692            | 21.5796  | 23.4341 (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 DWELLING EMISSIONS FOR REGULATIONS COMPLIANCE 09 Jan 2014

|                                                                 |                                          |          |          |          |          |          |          |          |          |          |          |                |
|-----------------------------------------------------------------|------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
|                                                                 | 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                                                      | 14.1437                                  | 12.7639  | 14.1060  | 13.6080  | 14.0283  | 13.5373  | 13.9646  | 14.0059  | 13.5758  | 14.0729  | 13.6581  | 14.1315 (61)   |
| Total heat required for water heating calculated for each month |                                          |          |          |          |          |          |          |          |          |          |          |                |
|                                                                 | 175.4609                                 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674 | 157.5221 | 170.3586 (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                                                 | 175.4609                                 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674 | 157.5221 | 170.3586 (64)  |
|                                                                 | Total per year (kWh/year) = Sum(64)m =   |          |          |          |          |          |          |          |          |          |          | 1721.5308 (64) |
| Heat gains from water heating, kWh/month                        |                                          |          |          |          |          |          |          |          |          |          |          |                |
|                                                                 | 57.1739                                  | 50.1031  | 51.9356  | 45.6062  | 44.0030  | 38.3292  | 35.8728  | 40.6598  | 40.9961  | 47.3399  | 51.2493  | 55.4784 (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                                                                               | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 22.6130   | 20.0847   | 16.3339   | 12.3658   | 9.2436    | 7.8038    | 8.4323    | 10.9607   | 14.7114   | 18.6795   | 21.8017   | 23.2415 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 253.6489  | 256.2810  | 249.6482  | 235.5278  | 217.7034  | 200.9510  | 189.7593  | 187.1272  | 193.7600  | 207.8804  | 225.7048  | 242.4572 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191 (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)                                 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 (71) |
| Water heating gains (Table 5)                                                       |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 76.8466   | 74.5581   | 69.8059   | 63.3420   | 59.1438   | 53.2351   | 48.2161   | 54.6503   | 56.9390   | 63.6289   | 71.1796   | 74.5677 (72)   |
| Total internal gains                                                                |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 419.9657  | 417.7810  | 402.6453  | 378.0929  | 352.9481  | 328.8471  | 313.2650  | 319.5955  | 332.2677  | 357.0460  | 385.5433  | 407.1236 (73)  |

#### 6. Solar gains

| [Jan]       |          |          |          |           | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d |          | Gains<br>W    |               |
|-------------|----------|----------|----------|-----------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|----------|---------------|---------------|
| North       |          |          |          |           | 13.3500    | 10.6334                        | 0.7200                            | 0.7000                             | 0.7700                       |          | 49.5812 (74)  |               |
| East        |          |          |          |           | 1.8900     | 19.6403                        | 0.7200                            | 0.7000                             | 0.7700                       |          | 12.9650 (76)  |               |
| South       |          |          |          |           | 9.9500     | 46.7521                        | 0.7200                            | 0.7000                             | 0.7700                       |          | 162.4754 (78) |               |
|             |          |          |          |           |            |                                |                                   |                                    |                              |          |               |               |
| Solar gains | 225.0216 | 386.2073 | 541.7303 | 702.6278  | 822.2447   | 833.5592                       | 796.3274                          | 703.2859                           | 596.2394                     | 429.8907 | 269.9194      | 192.3888 (83) |
| Total gains | 644.9873 | 803.9884 | 944.3756 | 1080.7207 | 1175.1928  | 1162.4063                      | 1109.5923                         | 1022.8814                          | 928.5070                     | 786.9367 | 655.4627      | 599.5125 (84) |

#### 7. Mean internal temperature (heating season)

|                                                                             |         |         |         |         |         |         |         |         |         |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         |              |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | Jan     | Feb     | Mar     | Apr     | May     | Jun     | Jul     | Aug     | Sep     | Oct     | Nov     | Dec          |
| tau                                                                         | 51.6631 | 51.8121 | 51.9590 | 52.6601 | 52.7934 | 53.4228 | 53.4228 | 53.5410 | 53.1786 | 52.7934 | 52.5244 | 52.2462      |
| alpha                                                                       | 4.4442  | 4.4541  | 4.4639  | 4.5107  | 4.5196  | 4.5615  | 4.5615  | 4.5694  | 4.5452  | 4.5196  | 4.5016  | 4.4831       |
| util living area                                                            |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 0.9970  | 0.9917  | 0.9776  | 0.9336  | 0.8284  | 0.6550  | 0.4955  | 0.5535  | 0.8001  | 0.9612  | 0.9934  | 0.9978 (86)  |
| MIT                                                                         |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 19.5568 | 19.7771 | 20.0923 | 20.4808 | 20.7870 | 20.9471 | 20.9881 | 20.9808 | 20.8669 | 20.4539 | 19.9293 | 19.5223 (87) |
| Th 2                                                                        |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 19.8064 | 19.8094 | 19.8123 | 19.8262 | 19.8288 | 19.8409 | 19.8409 | 19.8432 | 19.8362 | 19.8288 | 19.8235 | 19.8180 (88) |
| util rest of house                                                          |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 0.9960  | 0.9889  | 0.9696  | 0.9099  | 0.7707  | 0.5557  | 0.3708  | 0.4242  | 0.7143  | 0.9424  | 0.9906  | 0.9971 (89)  |
| MIT 2                                                                       |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 17.9049 | 18.2273 | 18.6839 | 19.2374 | 19.6305 | 19.8081 | 19.8369 | 19.8359 | 19.7362 | 19.2146 | 18.4603 | 17.8623 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 18.2223 | 18.5251 | 18.9545 | 19.4763 | 19.8527 | 20.0269 | 20.0581 | 20.0559 | 19.9534 | 19.4528 | 18.7426 | 18.1813 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 18.0723 | 18.3751 | 18.8045 | 19.3263 | 19.7027 | 19.8769 | 19.9081 | 19.9059 | 19.8034 | 19.3028 | 18.5926 | 18.0313 (93) |

#### 8. Space heating requirement

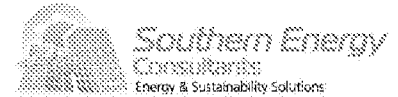
|                      | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct       | Nov          | Dec            |
|----------------------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|--------------|----------------|
| Utilisation          | 0.9936    | 0.9838    | 0.9602    | 0.8970    | 0.7635    | 0.5590   | 0.3783   | 0.4316   | 0.7115   | 0.9308    | 0.9861       | 0.9953 (94)    |
| Useful gains         | 640.8376  | 790.9336  | 906.8168  | 969.4266  | 897.2436  | 649.8180 | 419.7421 | 441.4664 | 660.6009 | 732.4664  | 646.3614     | 596.6653 (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     |           |           |           |           |           |          |          |          |          |           |              |                |
|                      | 1820.8875 | 1776.4671 | 1617.5544 | 1352.4040 | 1035.4162 | 674.6992 | 422.9729 | 447.2693 | 732.5815 | 1125.9865 | 1494.5586    | 1808.2737 (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    |           |           |           |           |           |          |          |          |          |           |              |                |
|                      | 877.9571  | 662.2785  | 528.7888  | 275.7438  | 102.8004  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 292.7790  | 610.7020     | 901.4366 (98)  |
| Space heating        |           |           |           |           |           |          |          |          |          |           |              | 4252.4862 (98) |
| Space heating per m2 |           |           |           |           |           |          |          |          |          |           | (98) / (4) = | 43.2339 (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                                             |          |          |          |          |          |          |          |          |          |           |          |          | 4698.8798 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct       | Nov      | Dec      |                 |
| Space heating requirement                                             | 877.9571 | 662.2785 | 528.7888 | 275.7438 | 102.8004 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 292.7790  | 610.7020 | 901.4366 | (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)                              | 970.1184 | 731.7995 | 584.2970 | 304.6893 | 113.5916 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 323.5127  | 674.8088 | 996.0626 | (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                                             | 175.4609 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674  | 157.5221 | 170.3586 | (64)            |
| Efficiency of water heater (217)m                                     | 89.9508  | 89.8789  | 89.7370  | 89.3938  | 88.6504  | 87.3000  | 87.3000  | 87.3000  | 87.3000  | 89.4102   | 89.8249  | 87.3000  | (216)           |
| Fuel for water heating, kWh/month                                     | 195.0631 | 171.1779 | 177.9613 | 157.2123 | 153.2092 | 135.8932 | 127.5520 | 144.0554 | 145.0917 | 163.1441  | 175.3658 | 189.3382 | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |           |          |          | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |           |          |          |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |           |          |          | 4698.8798 (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)                   |          |          |          |          |          |          |          |          |          |           |          |          | 399.3523 (232)  |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |          |          |          |          |          |           |          |          |                 |
| PV Unit 0 (0.80 * 0.75 * 1080 * 0.80) =                               |          |          |          |          |          |          |          |          |          | -518.1718 |          |          | -518.1718 (233) |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |           |          |          | 6590.1248 (238) |

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

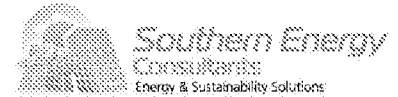
|                                             | Energy<br>kWh/year | Emission factor<br>kg CO2/kWh | Emissions<br>kg CO2/year |
|---------------------------------------------|--------------------|-------------------------------|--------------------------|
| Space heating - main system 1               | 4698.8798          | 0.2160                        | 1014.9580 (261)          |
| Space heating - secondary                   | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)                  | 1935.0644          | 0.2160                        | 417.9739 (264)           |
| Space and water heating                     |                    |                               | 1432.9320 (265)          |
| Pumps and fans                              | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                         | 399.3523           | 0.5190                        | 207.2639 (268)           |
| Energy saving/generation technologies       |                    |                               |                          |
| PV Unit                                     | -518.1718          | 0.5190                        | -268.9312 (269)          |
| Total CO2, kg/year                          |                    |                               | 1410.1896 (272)          |
| Dwelling Carbon Dioxide Emission Rate (DER) |                    |                               | 14.3400 (273)            |

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

|                                                                                 |     |             |
|---------------------------------------------------------------------------------|-----|-------------|
| DER                                                                             |     | 14.3400 ZC1 |
| Total Floor Area                                                                | TFA | 98.3600     |
| Assumed number of occupants                                                     | N   | 2.7238      |
| CO2 emission factor in Table 12 for electricity displaced from grid             | EF  | 0.5190      |
| CO2 emissions from appliances, equation (L14)                                   |     | 15.2813 ZC2 |
| CO2 emissions from cooking, equation (L16)                                      |     | 1.8745 ZC3  |
| Total CO2 emissions                                                             |     | 31.4958 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                                                               |     | 31.4958 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                                           | 51.9700 (1b)              | x 2.3500 (2b)                   | = 122.1295 (1b) - (3b)      |
| First floor                                            | 46.3900 (1c)              | x 2.6500 (2c)                   | = 122.9335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 98.3600                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 245.0630 (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) =             | 0.1224 (8)   |        |        |        |              |
| Pressure test                                        |                              |        |                      |        |        |        | Yes                         |              |        |        |        |              |
| Measured/design AP50                                 |                              |        |                      |        |        |        | 5.0000                      |              |        |        |        |              |
| Infiltration rate                                    |                              |        |                      |        |        |        | 0.3724                      | (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) =        | 0.3166 (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                                      | 0.4036                       | 0.3957 | 0.3878               | 0.3482 | 0.3403 | 0.3007 | 0.3007                      | 0.2928       | 0.3166 | 0.3403 | 0.3561 | 0.3720 (22b) |
| Effective ac                                         | 0.5814                       | 0.5783 | 0.5752               | 0.5606 | 0.5579 | 0.5452 | 0.5452                      | 0.5429       | 0.5501 | 0.5579 | 0.5634 | 0.5692 (25)  |

#### 3. Heat losses and heat loss parameter

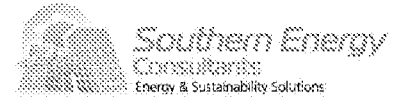
| Element                                                             | Gross<br>m2    | Openings<br>m2 | NetArea<br>m2         | U-value<br>W/m2K | A x U<br>W/K   | K-value<br>kJ/m2K | A x K<br>kJ/K  |                |                |                |                |                     |
|---------------------------------------------------------------------|----------------|----------------|-----------------------|------------------|----------------|-------------------|----------------|----------------|----------------|----------------|----------------|---------------------|
| TER Opaque door                                                     |                |                | 1.9500                | 1.0000           | 1.9500         |                   | (26)           |                |                |                |                |                     |
| TER Opening Type (Uw = 1.40)                                        |                |                | 22.6400               | 1.3258           | 30.0152        |                   | (27)           |                |                |                |                |                     |
| Heat Loss Floor 1                                                   |                |                | 51.9700               | 0.1300           | 6.7561         |                   | (28a)          |                |                |                |                |                     |
| External Wall 1                                                     | 144.8800       | 24.5900        | 120.2900              | 0.1800           | 21.6522        |                   | (29a)          |                |                |                |                |                     |
| External Roof 1                                                     | 51.9700        |                | 51.9700               | 0.1300           | 6.7561         |                   | (30)           |                |                |                |                |                     |
| Total net area of external elements Aum(A, m2)                      |                |                | 248.8200              |                  |                |                   | (31)           |                |                |                |                |                     |
| Fabric heat loss, W/K = Sum (A x U)                                 |                |                | (26)... (30) + (32) = |                  | 67.1296        |                   | (33)           |                |                |                |                |                     |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |                |                |                       |                  |                |                   | 250.0000 (35)  |                |                |                |                |                     |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |                |                |                       |                  |                |                   | 11.9455 (36)   |                |                |                |                |                     |
| Total fabric heat loss                                              |                |                |                       |                  |                | (33) + (36) =     | 79.0751 (37)   |                |                |                |                |                     |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                       |                  |                |                   |                |                |                |                |                |                     |
| (38)m                                                               | Jan<br>47.0223 | Feb<br>46.7665 | Mar<br>46.5158        | Apr<br>45.3382   | May<br>45.1179 | Jun<br>44.0922    | Jul<br>44.0922 | Aug<br>43.9023 | Sep<br>44.4873 | Oct<br>45.1179 | Nov<br>45.5636 | Dec<br>46.0296 (38) |
| Heat transfer coeff                                                 | 126.0973       | 125.8416       | 125.5908              | 124.4133         | 124.1929       | 123.1673          | 123.1673       | 122.9774       | 123.5624       | 124.1929       | 124.6386       | 125.1046 (39)       |
| Average = Sum(39)m / 12 =                                           |                |                |                       |                  |                |                   |                |                |                |                |                | 124.4122 (39)       |
| HLP                                                                 | Jan<br>1.2820  | Feb<br>1.2794  | Mar<br>1.2768         | Apr<br>1.2649    | May<br>1.2626  | Jun<br>1.2522     | Jul<br>1.2522  | Aug<br>1.2503  | Sep<br>1.2562  | Oct<br>1.2626  | Nov<br>1.2672  | Dec<br>1.2719 (40)  |
| HLP (average)                                                       |                |                |                       |                  |                |                   |                |                |                |                |                | 1.2649 (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                            |                      |          |          |          |          |          |         |          |          |          |                    | 2.7238 (42)    |
| Average daily hot water use (litres/day)     |                      |          |          |          |          |          |         |          |          |          |                    | 98.8906 (43)   |
|                                              | Jan                  | Feb      | Mar      | Apr      | May      | Jun      | Jul     | Aug      | Sep      | Oct      | Nov                | Dec            |
| Daily hot water use                          | 108.7797             | 104.8241 | 100.8685 | 96.9128  | 92.9572  | 89.0016  | 89.0016 | 92.9572  | 96.9128  | 100.8685 | 104.8241           | 108.7797 (44)  |
| Energy conte                                 | 161.3172             | 141.0890 | 145.5912 | 126.9300 | 121.7923 | 105.0975 | 97.3883 | 111.7545 | 113.0892 | 131.7946 | 143.8641           | 156.2271 (45)  |
| Energy content (annual)                      |                      |          |          |          |          |          |         |          |          |          | Total = Sum(45)m = | 1555.9348 (45) |
| Distribution loss                            | (46)m = 0.15 x (45)m |          |          |          |          |          |         |          |          |          |                    |                |
|                                              | 24.1976              | 21.1634  | 21.8387  | 19.0395  | 18.2688  | 15.7646  | 14.6082 | 16.7632  | 16.9634  | 19.7692  | 21.5796            | 23.4341 (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 (57)   |
| Total heat required for water heating calculated for each month | 50.9589  | 46.0274  | 50.9589  | 47.7926  | 47.3700  | 43.8912  | 45.3542  | 47.3700  | 47.7926  | 50.9589  | 49.3151  | 50.9589 (61)  |
| Solar input                                                     | 212.2761 | 187.1164 | 196.5501 | 174.7226 | 169.1623 | 148.9887 | 142.7425 | 159.1245 | 160.8818 | 182.7535 | 193.1791 | 207.1860 (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                        | 212.2761 | 187.1164 | 196.5501 | 174.7226 | 169.1623 | 148.9887 | 142.7425 | 159.1245 | 160.8818 | 182.7535 | 193.1791 | 207.1860 (64) |
|                                                                 | 66.3777  | 58.4189  | 61.1488  | 54.1524  | 52.3384  | 45.9177  | 43.7202  | 49.0009  | 49.5503  | 56.5614  | 60.1636  | 64.6852 (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                                                                               | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 22.6130   | 20.0847   | 16.3339   | 12.3658   | 9.2436    | 7.8038    | 8.4323    | 10.9607   | 14.7114   | 18.6795   | 21.8017   | 23.2415   | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 253.6489  | 256.2810  | 249.6482  | 235.5278  | 217.7034  | 200.9510  | 189.7593  | 187.1272  | 193.7600  | 207.8804  | 225.7048  | 242.4572  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | (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)                                 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | (71) |
| Water heating gains (Table 5)                                                       | 89.2173   | 86.9330   | 82.1893   | 75.2116   | 70.3474   | 63.7746   | 58.7637   | 65.8614   | 68.8199   | 76.0234   | 83.5605   | 86.9425   | (72) |
| Total internal gains                                                                | 432.3364  | 430.1558  | 415.0286  | 389.9625  | 364.1516  | 339.3867  | 323.8126  | 330.8065  | 344.1485  | 369.4405  | 397.9242  | 419.4984  | (73) |

#### 6. Solar gains

| [Jan]       |          |          |          | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W    |          |          |               |
|-------------|----------|----------|----------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|---------------|----------|----------|---------------|
| North       |          |          |          | 12.0000    | 10.6334                        | 0.6300                            | 0.7000                             | 0.7700                       | 38.9964 (74)  |          |          |               |
| East        |          |          |          | 1.7000     | 19.6403                        | 0.6300                            | 0.7000                             | 0.7700                       | 10.2039 (76)  |          |          |               |
| South       |          |          |          | 8.9400     | 46.7521                        | 0.6300                            | 0.7000                             | 0.7700                       | 127.7351 (78) |          |          |               |
|             |          |          |          |            |                                |                                   |                                    |                              |               |          |          |               |
| Solar gains | 176.9354 | 303.6824 | 425.9879 | 552.5316   | 646.6141                       | 655.5190                          | 626.2367                           | 553.0563                     | 468.8586      | 338.0355 | 212.2399 | 151.2754 (83) |
| Total gains | 609.2719 | 733.8382 | 841.0165 | 942.4942   | 1010.7657                      | 994.9057                          | 950.0492                           | 883.8628                     | 813.0071      | 707.4760 | 610.1641 | 570.7739 (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                                                                         | 54.1689 | 54.2790 | 54.3874 | 54.9022 | 54.9996 | 55.4575 | 55.4575 | 55.5432 | 55.2802 | 54.9996 | 54.8029 | 54.5988      |              |
| alpha                                                                       | 4.6113  | 4.6186  | 4.6258  | 4.6601  | 4.6666  | 4.6972  | 4.6972  | 4.7029  | 4.6853  | 4.6666  | 4.6535  | 4.6399       |              |
| util living area                                                            | 0.9977  | 0.9941  | 0.9847  | 0.9546  | 0.8737  | 0.7173  | 0.5521  | 0.6094  | 0.8431  | 0.9718  | 0.9949  | 0.9983 (86)  |              |
| MIT                                                                         | 19.6033 | 19.7906 | 20.0734 | 20.4335 | 20.7456 | 20.9300 | 20.9837 | 20.9746 | 20.8435 | 20.4348 | 19.9479 | 19.5690 (87) |              |
| Th 2                                                                        | 19.8550 | 19.8570 | 19.8590 | 19.8684 | 19.8702 | 19.8785 | 19.8785 | 19.8800 | 19.8753 | 19.8702 | 19.8666 | 19.8629 (88) |              |
| util rest of house                                                          | 0.9969  | 0.9921  | 0.9791  | 0.9371  | 0.8251  | 0.6198  | 0.4206  | 0.4758  | 0.7665  | 0.9576  | 0.9928  | 0.9977 (89)  |              |
| MIT 2                                                                       | 18.0058 | 18.2801 | 18.6913 | 19.2090 | 19.6226 | 19.8325 | 19.8727 | 19.8698 | 19.7512 | 19.2209 | 18.5174 | 17.9612 (90) |              |
| Living area fraction                                                        | 18.3127 | 18.5703 | 18.9568 | 19.4443 | 19.8384 | 20.0434 | 20.0862 | 20.0821 | 19.9611 | 19.4542 | 18.7922 | 18.2701 (92) |              |
| MIT                                                                         | 18.3127 | 18.5703 | 18.9568 | 19.4443 | 19.8384 | 20.0434 | 20.0862 | 20.0821 | 19.9611 | 19.4542 | 18.7922 | 18.2701 (93) |              |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |         |         | 0.0000       |              |
| adjusted MIT                                                                | 18.3127 | 18.5703 | 18.9568 | 19.4443 | 19.8384 | 20.0434 | 20.0862 | 20.0821 | 19.9611 | 19.4542 | 18.7922 | 18.2701 (93) |              |

#### 8. Space heating requirement

|                      | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct       | Nov       | Dec                       |
|----------------------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|-----------|---------------------------|
| Utilisation          | 0.9952    | 0.9887    | 0.9730    | 0.9287    | 0.8235    | 0.6354   | 0.4460   | 0.5013   | 0.7733   | 0.9504    | 0.9898    | 0.9964 (94)               |
| Useful gains         | 606.3210  | 725.5432  | 818.3007  | 875.3238  | 832.3801  | 632.1616 | 423.6764 | 443.0936 | 628.7354 | 672.3735  | 603.9481  | 568.6962 (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     | 1766.9686 | 1720.2947 | 1564.4654 | 1311.8554 | 1010.7312 | 670.4435 | 429.3824 | 452.8151 | 724.2071 | 1099.6237 | 1457.3045 | 1760.2383 (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    | 863.5218  | 668.4730  | 555.1466  | 314.3028  | 132.6932  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 317.8741  | 614.4166  | 886.5074 (98)             |
| Space heating        |           |           |           |           |           |          |          |          |          |           |           | 4352.9354 (98)            |
| Space heating per m2 |           |           |           |           |           |          |          |          |          |           |           | (98) / (4) = 44.2551 (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

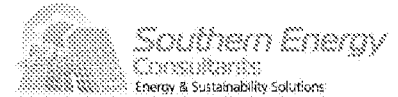
|                                                                       |          |          |          |          |          |          |          |          |          |          |          |                 |
|-----------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------------|
| 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                                             |          |          |          |          |          |          |          |          |          |          |          | 4660.5305 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov      | Dec             |
| Space heating requirement                                             | 863.5218 | 668.4730 | 555.1466 | 314.3028 | 132.6932 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 317.8741 | 614.4166 | 886.5074 (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)                              | 924.5416 | 715.7099 | 594.3753 | 336.5126 | 142.0698 | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 340.3363 | 657.8336 | 949.1514 (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                                             | 212.2761 | 187.1164 | 196.5501 | 174.7226 | 169.1623 | 148.9887 | 142.7425 | 159.1245 | 160.8818 | 182.7535 | 193.1791 | 207.1860 (64)   |
| Efficiency of water heater (217)m                                     | 88.2107  | 87.9799  | 87.5216  | 86.5122  | 84.4475  | 80.3000  | 80.3000  | 80.3000  | 80.3000  | 86.4315  | 87.7596  | 80.3000 (216)   |
| Fuel for water heating, kWh/month                                     | 240.6465 | 212.6809 | 224.5733 | 201.9629 | 200.3164 | 185.5401 | 177.7615 | 198.1625 | 200.3510 | 211.4432 | 220.1230 | 2508.2102 (219) |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |          |          | 2508.2102 (219) |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |          |          |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |          |          | 4660.5305 (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)                   |          |          |          |          |          |          |          |          |          |          |          | 399.3523 (232)  |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |          |          | 7643.0930 (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                                                                     | 4660.5305          | 0.2160                        | 1006.6746 (261)          |
| Space heating - secondary                                                                         | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)                                                                        | 2508.2102          | 0.2160                        | 541.7734 (264)           |
| Space and water heating                                                                           |                    |                               | 1548.4480 (265)          |
| Pumps and fans                                                                                    | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                                                                               | 399.3523           | 0.5190                        | 207.2639 (268)           |
| Total CO2, kg/m2/year                                                                             |                    |                               | 1794.6368 (272)          |
| Emissions per m2 for space and water heating                                                      |                    |                               | 15.7427 (272a)           |
| Fuel factor (mains gas)                                                                           |                    |                               | 1.0000                   |
| Emissions per m2 for lighting                                                                     |                    |                               | 2.1072 (272b)            |
| Emissions per m2 for pumps and fans                                                               |                    |                               | 0.3957 (272c)            |
| Target Carbon Dioxide Emission Rate (TER) = (15.7427 * 1.00) + 2.1072 + 0.3957, rounded to 2 d.p. |                    |                               | 18.2500 (273)            |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF FABRIC ENERGY EFFICIENCY 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                                           | 51.9700 (1b)              | x 2.3500 (2b)                   | = 122.1295 (1b) - (3b)      |
| First floor                                            | 46.3900 (1c)              | x 2.6500 (2c)                   | = 122.9335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 98.3600                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 245.0630 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|---------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 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)       |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = |                 |                      |       |                             | 30.0000 / (5) = 0.1224 (8) |
| Pressure test                                                             |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                      |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                         |                 |                      |       |                             | 0.3724 (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) =        | 0.3166 (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 | 0.4036 | 0.3957 | 0.3878 | 0.3482 | 0.3403 | 0.3007 | 0.3007 | 0.2928 | 0.3166 | 0.3403 | 0.3561 | 0.3720 (22b) |
| Effective ac    | 0.5814 | 0.5783 | 0.5752 | 0.5606 | 0.5579 | 0.5452 | 0.5452 | 0.5429 | 0.5501 | 0.5579 | 0.5634 | 0.5692 (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                                                      |                |                | 1.9500         | 1.5000                | 2.9250         |                   | (26)           |                |                |                |                |                     |
| Opening Type 2 (Uw = 1.30)                                          |                |                | 25.1900        | 1.2357                | 31.1283        |                   | (27)           |                |                |                |                |                     |
| Heat Loss Floor 1                                                   |                |                | 51.9700        | 0.1500                | 7.7955         |                   | (28a)          |                |                |                |                |                     |
| External Wall 1                                                     | 144.8800       | 27.1400        | 117.7400       | 0.2400                | 28.2576        |                   | (29a)          |                |                |                |                |                     |
| External Roof 1                                                     | 51.9700        |                | 51.9700        | 0.1100                | 5.7167         |                   | (30)           |                |                |                |                |                     |
| Total net area of external elements Aum(A, m2)                      |                |                | 248.8200       |                       |                |                   | (31)           |                |                |                |                |                     |
| Fabric heat loss, W/K = Sum (A x U)                                 |                |                |                | (26)... (30) + (32) = | 75.8231        |                   | (33)           |                |                |                |                |                     |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |                |                |                |                       |                |                   | 250.0000 (35)  |                |                |                |                |                     |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |                |                |                |                       |                |                   | 6.1647 (36)    |                |                |                |                |                     |
| Total fabric heat loss                                              |                |                |                |                       |                | (33) + (36) =     | 81.9878 (37)   |                |                |                |                |                     |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                |                       |                |                   |                |                |                |                |                |                     |
| (38)m                                                               | Jan<br>47.0223 | Feb<br>46.7665 | Mar<br>46.5158 | Apr<br>45.3382        | May<br>45.1179 | Jun<br>44.0922    | Jul<br>44.0922 | Aug<br>43.9023 | Sep<br>44.4873 | Oct<br>45.1179 | Nov<br>45.5636 | Dec<br>46.0296 (38) |
| Heat transfer coeff                                                 | 129.0101       | 128.7543       | 128.5036       | 127.3260              | 127.1057       | 126.0801          | 126.0801       | 125.8901       | 126.4751       | 127.1057       | 127.5514       | 128.0174 (39)       |
| Average = Sum(39)m / 12 =                                           |                |                |                |                       |                |                   |                |                |                |                |                | 127.3250 (39)       |
| HLP                                                                 | Jan<br>1.3116  | Feb<br>1.3090  | Mar<br>1.3065  | Apr<br>1.2945         | May<br>1.2922  | Jun<br>1.2818     | Jul<br>1.2818  | Aug<br>1.2799  | Sep<br>1.2858  | Oct<br>1.2922  | Nov<br>1.2968  | Dec<br>1.3015 (40)  |
| HLP (average)                                                       |                |                |                |                       |                |                   |                |                |                |                |                | 1.2945 (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                            |          |          |          |          |          |          |         |          |          |                    |          | 2.7238 (42)    |
| Average daily hot water use (litres/day)     |          |          |          |          |          |          |         |          |          |                    |          | 98.8906 (43)   |
| Daily hot water use                          | 108.7797 | 104.8241 | 100.8685 | 96.9128  | 92.9572  | 89.0016  | 89.0016 | 92.9572  | 96.9128  | 100.8685           | 104.8241 | 108.7797 (44)  |
| Energy conte                                 | 161.3172 | 141.0890 | 145.5912 | 126.9300 | 121.7923 | 105.0975 | 97.3883 | 111.7545 | 113.0892 | 131.7946           | 143.8641 | 156.2271 (45)  |
| Energy content (annual)                      |          |          |          |          |          |          |         |          |          | Total = Sum(45)m = |          | 1555.9348 (45) |
| Distribution loss (46)m = 0.15 x (45)m       | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000   | 0.0000   | 0.0000             | 0.0000   | 0.0000 (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 FABRIC ENERGY EFFICIENCY 09 Jan 2014

|                                          |         |         |         |         |         |         |         |         |         |         |         |              |
|------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Primary 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)  |
| Heat gains from water heating, kWh/month | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000 (59)  |
|                                          | 34.2799 | 29.9814 | 30.9381 | 26.9726 | 25.8809 | 22.3332 | 20.6950 | 23.7478 | 24.0315 | 28.0063 | 30.5711 | 33.1982 (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                                                                               | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 22.6130   | 20.0847   | 16.3339   | 12.3658   | 9.2436    | 7.8038    | 8.4323    | 10.9607   | 14.7114   | 18.6795   | 21.8017   | 23.2415 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 253.6489  | 256.2810  | 249.6482  | 235.5278  | 217.7034  | 200.9510  | 189.7593  | 187.1272  | 193.7600  | 207.8804  | 225.7048  | 242.4572 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191 (69)   |
| Pumps, fans                                                                         | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000 (70)    |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 (71) |
| Water heating gains (Table 5)                                                       | 46.0751   | 44.6152   | 41.5835   | 37.4620   | 34.7861   | 31.0184   | 27.8159   | 31.9191   | 33.3770   | 37.6429   | 42.4599   | 44.6213 (72)   |
| Total internal gains                                                                | 386.1942  | 384.8381  | 371.4229  | 349.2129  | 325.5904  | 303.6304  | 289.8648  | 293.8643  | 305.7056  | 328.0600  | 353.8236  | 374.1772 (73)  |

#### 6. Solar gains

| [Jan] | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W    |
|-------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|---------------|
| North | 13.3500    | 10.6334                        | 0.7200                            | 0.7000                             | 0.7700                       | 49.5812 (74)  |
| East  | 1.8900     | 19.6403                        | 0.7200                            | 0.7000                             | 0.7700                       | 12.9650 (76)  |
| South | 9.9500     | 46.7521                        | 0.7200                            | 0.7000                             | 0.7700                       | 162.4754 (78) |

|             |          |          |          |           |           |           |           |          |          |          |          |               |
|-------------|----------|----------|----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|---------------|
| Solar gains | 225.0216 | 386.2073 | 541.7303 | 702.6278  | 822.2447  | 833.5592  | 796.3274  | 703.2859 | 596.2394 | 429.8907 | 269.9194 | 192.3888 (83) |
| Total gains | 611.2158 | 771.0454 | 913.1532 | 1051.8407 | 1147.8351 | 1137.1896 | 1086.1922 | 997.1502 | 901.9450 | 757.9507 | 623.7430 | 566.5661 (84) |

#### 7. Mean internal temperature (heating season)

|                                                                             |         |         |         |         |         |         |         |         |                           |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |                           |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |                           |         |         |              |
| tau                                                                         | 52.9459 | 53.0511 | 53.1546 | 53.6462 | 53.7392 | 54.1763 | 54.1763 | 54.2581 | 54.0071                   | 53.7392 | 53.5514 | 53.3565      |
| alpha                                                                       | 4.5297  | 4.5367  | 4.5436  | 4.5764  | 4.5826  | 4.6118  | 4.6118  | 4.6172  | 4.6005                    | 4.5826  | 4.5701  | 4.5571       |
| util living area                                                            | 0.9976  | 0.9929  | 0.9796  | 0.9372  | 0.8327  | 0.6600  | 0.4992  | 0.5600  | 0.8076                    | 0.9651  | 0.9945  | 0.9983 (86)  |
| MIT                                                                         | 19.5673 | 19.7868 | 20.1007 | 20.4838 | 20.7894 | 20.9474 | 20.9883 | 20.9807 | 20.8656                   | 20.4505 | 19.9281 | 19.5272 (87) |
| Th 2                                                                        | 19.8317 | 19.8338 | 19.8358 | 19.8452 | 19.8469 | 19.8551 | 19.8551 | 19.8566 | 19.8519                   | 19.8469 | 19.8434 | 19.8396 (88) |
| util rest of house                                                          | 0.9968  | 0.9905  | 0.9724  | 0.9145  | 0.7762  | 0.5615  | 0.3752  | 0.4310  | 0.7237                    | 0.9479  | 0.9922  | 0.9977 (89)  |
| MIT 2                                                                       | 18.5383 | 18.7582 | 19.0692 | 19.4436 | 19.7124 | 19.8327 | 19.8524 | 19.8516 | 19.7823                   | 19.4217 | 18.9073 | 18.5045 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.1922 (91)  |
| MIT                                                                         | 18.7360 | 18.9559 | 19.2674 | 19.6434 | 19.9193 | 20.0469 | 20.0707 | 20.0685 | 19.9904                   | 19.6194 | 19.1035 | 18.7010 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | 0.0000       |
| adjusted MIT                                                                | 18.7360 | 18.9559 | 19.2674 | 19.6434 | 19.9193 | 20.0469 | 20.0707 | 20.0685 | 19.9904                   | 19.6194 | 19.1035 | 18.7010 (93) |

#### 8. Space heating requirement

|                      |           |           |           |           |           |          |          |          |          |              |           |                |
|----------------------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|--------------|-----------|----------------|
| Utilisation          | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct          | Nov       | Dec            |
|                      | 0.9957    | 0.9879    | 0.9678    | 0.9097    | 0.7802    | 0.5791   | 0.3992   | 0.4559   | 0.7352   | 0.9435       | 0.9902    | 0.9969 (94)    |
| Useful gains         | 608.5702  | 761.7389  | 883.7545  | 956.8767  | 895.5551  | 658.5022 | 433.6128 | 454.6444 | 663.1363 | 715.1402     | 617.5993  | 564.8004 (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     | 1862.3946 | 1809.7518 | 1640.6561 | 1367.9200 | 1044.7221 | 686.7417 | 437.5833 | 461.8342 | 744.9933 | 1146.4176    | 1531.0581 | 1856.3852 (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 (97a)   |
| Space heating kWh    | 932.8454  | 704.2647  | 563.1348  | 295.9512  | 110.9803  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 320.8704     | 657.6904  | 960.9391 (98)  |
| Space heating        |           |           |           |           |           |          |          |          |          |              |           | 4546.6761 (98) |
| Space heating per m2 |           |           |           |           |           |          |          |          |          | (98) / (4) = |           | 46.2248 (99)   |

#### 8c. Space cooling requirement

|                                                     |        |        |        |        |         |           |           |           |         |         |        |                |
|-----------------------------------------------------|--------|--------|--------|--------|---------|-----------|-----------|-----------|---------|---------|--------|----------------|
| Calculated for June, July and August. See Table 10b |        |        |        |        |         |           |           |           |         |         |        |                |
| Ext. temp.                                          | Jan    | Feb    | Mar    | Apr    | May     | Jun       | Jul       | Aug       | Sep     | Oct     | Nov    | Dec            |
|                                                     | 4.3000 | 4.9000 | 6.5000 | 8.9000 | 11.7000 | 14.6000   | 16.6000   | 16.4000   | 14.1000 | 10.6000 | 7.1000 | 4.2000         |
| Heat loss rate W                                    | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1185.1527 | 932.9925  | 956.7650  | 0.0000  | 0.0000  | 0.0000 | 0.0000 (100)   |
| Utilisation                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 0.8902    | 0.9389    | 0.9161    | 0.0000  | 0.0000  | 0.0000 | 0.0000 (101)   |
| Useful loss                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1054.9690 | 875.9497  | 876.4581  | 0.0000  | 0.0000  | 0.0000 | 0.0000 (102)   |
| Total gains                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1433.2878 | 1371.4349 | 1269.1807 | 0.0000  | 0.0000  | 0.0000 | 0.0000 (103)   |
| Month fracti                                        | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1.0000    | 1.0000    | 1.0000    | 0.0000  | 0.0000  | 0.0000 | 0.0000 (103a)  |
| Space cooling kWh                                   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 272.3895  | 368.6409  | 292.1856  | 0.0000  | 0.0000  | 0.0000 | 0.0000 (104)   |
| Space cooling                                       |        |        |        |        |         |           |           |           |         |         |        | 933.2160 (104) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)

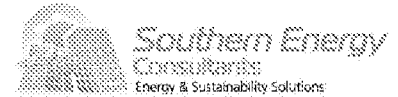


### CALCULATION OF FABRIC ENERGY EFFICIENCY 69 Jan 2014

|                                          |                          |        |        |        |        |         |         |         |        |        |                |
|------------------------------------------|--------------------------|--------|--------|--------|--------|---------|---------|---------|--------|--------|----------------|
| Cooled fraction                          | FC = cooled area / (4) = |        |        |        |        |         |         |         |        |        | 1.0000 (105)   |
| Intermittency factor (Table 10b)         | 0.0000                   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2500  | 0.2500  | 0.2500  | 0.0000 | 0.0000 | 0.0000 (106)   |
| Space cooling kWh                        | 0.0000                   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 68.0974 | 92.1602 | 73.0464 | 0.0000 | 0.0000 | 0.0000 (107)   |
| Space cooling                            |                          |        |        |        |        |         |         |         |        |        | 233.3040 (107) |
| Space cooling per m2                     |                          |        |        |        |        |         |         |         |        |        | 2.3719 (108)   |
| Energy for space heating                 |                          |        |        |        |        |         |         |         |        |        | 46.2248 (99)   |
| Energy for space cooling                 |                          |        |        |        |        |         |         |         |        |        | 2.3719 (108)   |
| Total                                    |                          |        |        |        |        |         |         |         |        |        | 48.5968 (109)  |
| Dwelling Fabric Energy Efficiency (DFEE) |                          |        |        |        |        |         |         |         |        |        | 48.6 (109)     |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 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                                           | 51.9700 (1b)              | x 2.3500 (2b)                   | = 122.1295 (1b) - (3b)      |
| First floor                                            | 46.3900 (1c)              | x 2.6500 (2c)                   | = 122.9335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 98.3600                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 245.0630 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|---------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 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)       |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = |                 |                      |       |                             | 30.0000 / (5) = 0.1224 (8) |
| Pressure test                                                             |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                      |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                         |                 |                      |       |                             | 0.3724 (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) =        | 0.3166 (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 | 0.4036 | 0.3957 | 0.3878 | 0.3482 | 0.3403 | 0.3007 | 0.3007 | 0.2928 | 0.3166 | 0.3403 | 0.3561 | 0.3720 (22b) |
| Effective ac    | 0.5814 | 0.5783 | 0.5752 | 0.5606 | 0.5579 | 0.5452 | 0.5452 | 0.5429 | 0.5501 | 0.5579 | 0.5634 | 0.5692 (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                                                     |                |                | 1.9500                | 1.0000           | 1.9500         |                   | (26)           |                |                |                |                |                     |
| TER Opening Type (Uw = 1.40)                                        |                |                | 22.6400               | 1.3258           | 30.0152        |                   | (27)           |                |                |                |                |                     |
| Heat Loss Floor 1                                                   |                |                | 51.9700               | 0.1300           | 6.7561         |                   | (28a)          |                |                |                |                |                     |
| External Wall 1                                                     | 144.8800       | 24.5900        | 120.2900              | 0.1800           | 21.6522        |                   | (29a)          |                |                |                |                |                     |
| External Roof 1                                                     | 51.9700        |                | 51.9700               | 0.1300           | 6.7561         |                   | (30)           |                |                |                |                |                     |
| Total net area of external elements Aum(A, m2)                      |                |                | 248.8200              |                  |                |                   | (31)           |                |                |                |                |                     |
| Fabric heat loss, W/K = Sum (A x U)                                 |                |                | (26)... (30) + (32) = |                  | 67.1296        |                   | (33)           |                |                |                |                |                     |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |                |                |                       |                  |                |                   | 250.0000 (35)  |                |                |                |                |                     |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |                |                |                       |                  |                |                   | 11.9455 (36)   |                |                |                |                |                     |
| Total fabric heat loss                                              |                |                |                       |                  |                | (33) + (36) =     | 79.0751 (37)   |                |                |                |                |                     |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |                |                |                       |                  |                |                   |                |                |                |                |                |                     |
| (38)m                                                               | Jan<br>47.0223 | Feb<br>46.7665 | Mar<br>46.5158        | Apr<br>45.3382   | May<br>45.1179 | Jun<br>44.0922    | Jul<br>44.0922 | Aug<br>43.9023 | Sep<br>44.4873 | Oct<br>45.1179 | Nov<br>45.5636 | Dec<br>46.0296 (38) |
| Heat transfer coeff                                                 | 126.0973       | 125.8416       | 125.5908              | 124.4133         | 124.1929       | 123.1673          | 123.1673       | 122.9774       | 123.5624       | 124.1929       | 124.6386       | 125.1046 (39)       |
| Average = Sum(39)m / 12 =                                           |                |                |                       |                  |                |                   |                |                |                |                |                | 124.4122 (39)       |
| HLP                                                                 | Jan<br>1.2820  | Feb<br>1.2794  | Mar<br>1.2768         | Apr<br>1.2649    | May<br>1.2626  | Jun<br>1.2522     | Jul<br>1.2522  | Aug<br>1.2503  | Sep<br>1.2562  | Oct<br>1.2626  | Nov<br>1.2672  | Dec<br>1.2719 (40)  |
| HLP (average)                                                       |                |                |                       |                  |                |                   |                |                |                |                |                | 1.2649 (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                            |                      |          |          |          |          |          |         |          |          |          |                    | 2.7238 (42)    |
| Average daily hot water use (litres/day)     |                      |          |          |          |          |          |         |          |          |          |                    | 98.8906 (43)   |
|                                              | Jan                  | Feb      | Mar      | Apr      | May      | Jun      | Jul     | Aug      | Sep      | Oct      | Nov                | Dec            |
| Daily hot water use                          | 108.7797             | 104.8241 | 100.8685 | 96.9128  | 92.9572  | 89.0016  | 89.0016 | 92.9572  | 96.9128  | 100.8685 | 104.8241           | 108.7797 (44)  |
| Energy conte                                 | 161.3172             | 141.0890 | 145.5912 | 126.9300 | 121.7923 | 105.0975 | 97.3883 | 111.7545 | 113.0892 | 131.7946 | 143.8641           | 156.2271 (45)  |
| Energy content (annual)                      |                      |          |          |          |          |          |         |          |          |          | Total = Sum(45)m = | 1555.9348 (45) |
| Distribution loss                            | (46)m = 0.15 x (45)m |          |          |          |          |          |         |          |          |          |                    |                |
|                                              | 0.0000               | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000  | 0.0000   | 0.0000   | 0.0000   | 0.0000             | 0.0000 (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 FABRIC ENERGY EFFICIENCY 09 Jan 2014

|                                          |         |         |         |         |         |         |         |         |         |         |         |              |
|------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Primary 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)  |
| Heat gains from water heating, kWh/month | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000  | 0.0000 (59)  |
|                                          | 34.2799 | 29.9814 | 30.9381 | 26.9726 | 25.8809 | 22.3332 | 20.6950 | 23.7478 | 24.0315 | 28.0063 | 30.5711 | 33.1982 (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                                                                               | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | 136.1908  | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 22.6130   | 20.0847   | 16.3339   | 12.3658   | 9.2436    | 7.8038    | 8.4323    | 10.9607   | 14.7114   | 18.6795   | 21.8017   | 23.2415   | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 253.6489  | 256.2810  | 249.6482  | 235.5278  | 217.7034  | 200.9510  | 189.7593  | 187.1272  | 193.7600  | 207.8804  | 225.7048  | 242.4572  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | 36.6191   | (69) |
| Pumps, fans                                                                         | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | (71) |
| Water heating gains (Table 5)                                                       | 46.0751   | 44.6152   | 41.5835   | 37.4620   | 34.7861   | 31.0184   | 27.8159   | 31.9191   | 33.3770   | 37.6429   | 42.4599   | 44.6213   | (72) |
| Total internal gains                                                                | 386.1942  | 384.8381  | 371.4229  | 349.2129  | 325.5904  | 303.6304  | 289.8648  | 293.8643  | 305.7056  | 328.0600  | 353.8236  | 374.1772  | (73) |

#### 6. Solar gains

| [Jan]       |          |          |          | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d |          | Gains<br>W    |          |               |
|-------------|----------|----------|----------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|----------|---------------|----------|---------------|
| North       |          |          |          | 12.0000    | 10.6334                        | 0.6300                            | 0.7000                             | 0.7700                       |          | 38.9964 (74)  |          |               |
| East        |          |          |          | 1.7000     | 19.6403                        | 0.6300                            | 0.7000                             | 0.7700                       |          | 10.2039 (76)  |          |               |
| South       |          |          |          | 8.9400     | 46.7521                        | 0.6300                            | 0.7000                             | 0.7700                       |          | 127.7351 (78) |          |               |
|             |          |          |          |            |                                |                                   |                                    |                              |          |               |          |               |
| Solar gains | 176.9354 | 303.6824 | 425.9879 | 552.5316   | 646.6141                       | 655.5190                          | 626.2367                           | 553.0563                     | 468.8586 | 338.0355      | 212.2399 | 151.2754 (83) |
| Total gains | 563.1297 | 688.5205 | 797.4108 | 901.7445   | 972.2044                       | 959.1495                          | 916.1014                           | 846.9205                     | 774.5643 | 666.0955      | 566.0635 | 525.4527 (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                                                                         | 54.1689 | 54.2790 | 54.3874 | 54.9022 | 54.9996 | 55.4575 | 55.4575 | 55.5432 | 55.2802                   | 54.9996 | 54.8029 | 54.9988 |              |
| alpha                                                                       | 4.6113  | 4.6186  | 4.6258  | 4.6601  | 4.6666  | 4.6972  | 4.6972  | 4.7029  | 4.6853                    | 4.6666  | 4.6535  | 4.6399  |              |
| util living area                                                            | 0.9983  | 0.9955  | 0.9876  | 0.9611  | 0.8864  | 0.7353  | 0.5700  | 0.6310  | 0.8612                    | 0.9774  | 0.9963  | 0.9988  | (86)         |
| MIT                                                                         | 19.5607 | 19.7494 | 20.0354 | 20.4026 | 20.7256 | 20.9222 | 20.9814 | 20.9707 | 20.8262                   | 20.4007 | 19.9076 | 19.5270 | (87)         |
| Th 2                                                                        | 19.8550 | 19.8570 | 19.8590 | 19.8684 | 19.8702 | 19.8785 | 19.8785 | 19.8800 | 19.8753                   | 19.8702 | 19.8666 | 19.8629 | (88)         |
| util rest of house                                                          | 0.9977  | 0.9939  | 0.9829  | 0.9456  | 0.8407  | 0.6384  | 0.4355  | 0.4950  | 0.7887                    | 0.9657  | 0.9947  | 0.9984  | (89)         |
| MIT 2                                                                       | 18.5500 | 18.7396 | 19.0247 | 19.3897 | 19.6855 | 19.8430 | 19.8739 | 19.8718 | 19.7791                   | 19.3949 | 18.9055 | 18.5226 | (90)         |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.1922  | (91)         |
| MIT                                                                         | 18.7442 | 18.9336 | 19.2189 | 19.5843 | 19.8854 | 20.0504 | 20.0867 | 20.0830 | 19.9803                   | 19.5881 | 19.0980 | 18.7156 | (92)         |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | 0.0000  |              |
| adjusted MIT                                                                | 18.7442 | 18.9336 | 19.2189 | 19.5843 | 19.8854 | 20.0504 | 20.0867 | 20.0830 | 19.9803                   | 19.5881 | 19.0980 | 18.7156 | (93)         |

#### 8. Space heating requirement

|                      |           |           |           |           |           |          |          |          |          |           |           |           |       |
|----------------------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|-----------|-----------|-------|
| Utilisation          | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct       | Nov       | Dec       |       |
| Useful gains         | 0.9969    | 0.9921    | 0.9795    | 0.9407    | 0.8414    | 0.6547   | 0.4616   | 0.5213   | 0.7968   | 0.9617    | 0.9932    | 0.9977    | (94)  |
| Ext temp.            | 561.3927  | 683.0733  | 781.0268  | 848.2563  | 818.0006  | 627.9295 | 422.8655 | 441.4981 | 617.1497 | 640.5872  | 562.2196  | 524.2679  | (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     | 1821.3750 | 1766.0105 | 1597.3793 | 1329.2672 | 1016.5678 | 671.3053 | 429.4498 | 452.9202 | 726.5842 | 1116.2622 | 1495.4184 | 1815.9675 | (97)  |
| Month fracti         | 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 kWh    | 937.4268  | 727.7338  | 607.3663  | 346.3278  | 147.7340  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 353.9022  | 671.9031  | 961.0246  | (98)  |
| Space heating        |           |           |           |           |           |          |          |          |          |           |           | 4753.4185 | (98)  |
| Space heating per m2 |           |           |           |           |           |          |          |          |          |           |           | 48.3267   | (99)  |

#### 8c. Space cooling requirement

|                                                     |        |        |        |        |         |           |           |           |         |         |        |          |        |
|-----------------------------------------------------|--------|--------|--------|--------|---------|-----------|-----------|-----------|---------|---------|--------|----------|--------|
| Calculated for June, July and August. See Table 10b | Jan    | Feb    | Mar    | Apr    | May     | Jun       | Jul       | Aug       | Sep     | Oct     | Nov    | Dec      |        |
| 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   |        |
| Heat loss rate W                                    | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1157.7726 | 911.4380  | 934.6279  | 0.0000  | 0.0000  | 0.0000 | 0.0000   | (100)  |
| Utilisation                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 0.8470    | 0.9105    | 0.8826    | 0.0000  | 0.0000  | 0.0000 | 0.0000   | (101)  |
| Useful loss                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 980.5926  | 829.8677  | 824.9386  | 0.0000  | 0.0000  | 0.0000 | 0.0000   | (102)  |
| Total gains                                         | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1225.1889 | 1172.6275 | 1093.5876 | 0.0000  | 0.0000  | 0.0000 | 0.0000   | (103)  |
| Month fracti                                        | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 1.0000    | 1.0000    | 1.0000    | 0.0000  | 0.0000  | 0.0000 | 0.0000   | (103a) |
| Space cooling kWh                                   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000  | 176.1093  | 255.0133  | 199.8748  | 0.0000  | 0.0000  | 0.0000 | 0.0000   | (104)  |
| Space cooling                                       |        |        |        |        |         |           |           |           |         |         |        | 630.9974 | (104)  |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



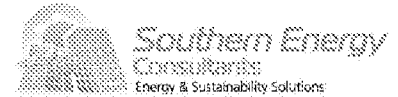
### CALCULATION OF TARGET FABRIC ENERGY EFFICIENCY 09 Jan 2014

|                                        |                          |        |        |        |        |         |         |         |        |        |                |
|----------------------------------------|--------------------------|--------|--------|--------|--------|---------|---------|---------|--------|--------|----------------|
| Cooled fraction                        | FC = cooled area / (4) = |        |        |        |        |         |         |         |        |        | 1.0000 (105)   |
| Intermittency factor (Table 10b)       | 0.0000                   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.2500  | 0.2500  | 0.2500  | 0.0000 | 0.0000 | 0.0000 (106)   |
| Space cooling kWh                      | 0.0000                   | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 44.0273 | 63.7533 | 49.9687 | 0.0000 | 0.0000 | 0.0000 (107)   |
| Space cooling                          |                          |        |        |        |        |         |         |         |        |        | 157.7494 (107) |
| Space cooling per m2                   |                          |        |        |        |        |         |         |         |        |        | 1.6038 (108)   |
| Energy for space heating               |                          |        |        |        |        |         |         |         |        |        | 48.3267 (99)   |
| Energy for space cooling               |                          |        |        |        |        |         |         |         |        |        | 1.6038 (108)   |
| Total                                  |                          |        |        |        |        |         |         |         |        |        | 49.9305 (109)  |
| Target Fabric Energy Efficiency (TFEE) |                          |        |        |        |        |         |         |         |        |        | 57.4 (109)     |

-----

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF HEAT DEMAND 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF HEAT DEMAND 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                                           | 51.9700 (1b)              | x 2.3500 (2b)                   | = 122.1295 (1b) - (3b)      |
| First floor                                            | 46.3900 (1c)              | x 2.6500 (2c)                   | = 122.9335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 98.3600                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 245.0630 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|---------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                               |                 |                      |       |                             | 5 * 10 = 50.0000 (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) = |                 |                      |       |                             | 50.0000 / (5) = 0.2040 (8) |
| Pressure test                                                             |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                      |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                         |                 |                      |       |                             | 0.4540 (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) =        | 0.3859 (21)                |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.6000 | 5.1000 | 4.8000 | 4.5000 | 4.7000 | 4.2000 | 4.4000 | 4.2000 | 4.4000 | 4.8000 | 4.9000 | 5.1000 (22)  |
| Wind factor     | 1.4000 | 1.2750 | 1.2000 | 1.1250 | 1.1750 | 1.0500 | 1.1000 | 1.0500 | 1.1000 | 1.2000 | 1.2250 | 1.2750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac    | 0.5403 | 0.4921 | 0.4631 | 0.4342 | 0.4535 | 0.4052 | 0.4245 | 0.4052 | 0.4245 | 0.4631 | 0.4728 | 0.4921 (22b) |
|                 | 0.6460 | 0.6211 | 0.6072 | 0.5942 | 0.6028 | 0.5821 | 0.5901 | 0.5821 | 0.5901 | 0.6072 | 0.6118 | 0.6211 (25)  |

#### 3. Heat losses and heat loss parameter

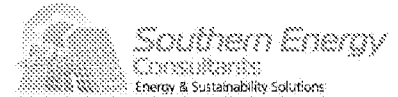
| Element                                                             | Gross<br>m2   | Openings<br>m2 | NetArea<br>m2        | U-value<br>W/m2K | A x U<br>W/K  | K-value<br>kJ/m2K | A x K<br>kJ/K |               |               |               |               |                    |
|---------------------------------------------------------------------|---------------|----------------|----------------------|------------------|---------------|-------------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| Opening Type 1                                                      |               |                | 1.9500               | 1.5000           | 2.9250        |                   | (26)          |               |               |               |               |                    |
| Opening Type 2 (Uw = 1.30)                                          |               |                | 25.1900              | 1.2357           | 31.1283       |                   | (27)          |               |               |               |               |                    |
| Heat Loss Floor 1                                                   |               |                | 51.9700              | 0.1500           | 7.7955        |                   | (28a)         |               |               |               |               |                    |
| External Wall 1                                                     | 144.8800      | 27.1400        | 117.7400             | 0.2400           | 28.2576       |                   | (29a)         |               |               |               |               |                    |
| External Roof 1                                                     | 51.9700       |                | 51.9700              | 0.1100           | 5.7167        |                   | (30)          |               |               |               |               |                    |
| Total net area of external elements Aum(A, m2)                      |               |                | 248.8200             |                  |               |                   | (31)          |               |               |               |               |                    |
| Fabric heat loss, W/K = Sum (A x U)                                 |               |                | (26)...(30) + (32) = |                  | 75.8231       |                   | (33)          |               |               |               |               |                    |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |               |                |                      |                  |               |                   | 250.0000 (35) |               |               |               |               |                    |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |               |                |                      |                  |               |                   | 6.1647 (36)   |               |               |               |               |                    |
| Total fabric heat loss                                              |               |                |                      |                  |               | (33) + (36) =     | 81.9878 (37)  |               |               |               |               |                    |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |               |                |                      |                  |               |                   |               |               |               |               |               |                    |
| (38)m                                                               | 52.2392       | 50.2255        | 49.1076              | 48.0575          | 48.7500       | 47.0751           | 47.7225       | 47.0751       | 47.7225       | 49.1076       | 49.4727       | 50.2255 (38)       |
| Heat transfer coeff                                                 | 134.2271      | 132.2133       | 131.0954             | 130.0453         | 130.7378      | 129.0629          | 129.7103      | 129.0629      | 129.7103      | 131.0954      | 131.4605      | 132.2133 (39)      |
| Average = Sum(39)m / 12 =                                           |               |                |                      |                  |               |                   |               |               |               |               |               | 130.8862 (39)      |
| HLP                                                                 | Jan<br>1.3647 | Feb<br>1.3442  | Mar<br>1.3328        | Apr<br>1.3221    | May<br>1.3292 | Jun<br>1.3121     | Jul<br>1.3187 | Aug<br>1.3121 | Sep<br>1.3187 | Oct<br>1.3328 | Nov<br>1.3365 | Dec<br>1.3442 (40) |
| HLP (average)                                                       |               |                |                      |                  |               |                   |               |               |               |               |               | 1.3307 (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                            |          |          |          |          |          |          |         |          |          |                    |          | 2.7238 (42)    |
| Average daily hot water use (litres/day)     |          |          |          |          |          |          |         |          |          |                    |          | 98.8906 (43)   |
| Daily hot water use                          | 108.7797 | 104.8241 | 100.8685 | 96.9128  | 92.9572  | 89.0016  | 89.0016 | 92.9572  | 96.9128  | 100.8685           | 104.8241 | 108.7797 (44)  |
| Energy conte                                 | 161.3172 | 141.0890 | 145.5912 | 126.9300 | 121.7923 | 105.0975 | 97.3883 | 111.7545 | 113.0892 | 131.7946           | 143.8641 | 156.2271 (45)  |
| Energy content (annual)                      |          |          |          |          |          |          |         |          |          | Total = Sum(45)m = |          | 1555.9348 (45) |
| Distribution loss (46)m = 0.15 x (45)m       | 24.1976  | 21.1634  | 21.8387  | 19.0395  | 18.2688  | 15.7646  | 14.6082 | 16.7632  | 16.9634  | 19.7692            | 21.5796  | 23.4341 (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 HEAT DEMAND 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 | 14.1437  | 12.7639  | 14.1060  | 13.6080  | 14.0283  | 13.5373  | 13.9646  | 14.0059  | 13.5758  | 14.0729  | 13.6581  | 14.1315 (61)  |
| Solar input                                                     | 175.4609 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674 | 157.5221 | 170.3586 (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)   |
| RHI water heating demand                                        | 175.4609 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674 | 157.5221 | 170.3586 (64) |
| Heat gains from water heating, kWh/month                        | 175.4609 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674 | 157.5221 | 170.3586 (64) |
|                                                                 | 57.1739  | 50.1031  | 51.9356  | 45.6062  | 44.0030  | 38.3292  | 35.8728  | 40.6598  | 40.9961  | 47.3399  | 51.2493  | 55.4784 (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                                                                               | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 56.5325   | 50.2116   | 40.8348   | 30.9146   | 23.1090   | 19.5096   | 21.0808   | 27.4017   | 36.7784   | 46.6987   | 54.5043   | 58.1037 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 378.5804  | 382.5089  | 372.6093  | 351.5341  | 324.9305  | 299.9268  | 283.2229  | 279.2944  | 289.1940  | 310.2692  | 336.8728  | 361.8764 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667 (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)                                 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 (71) |
| Water heating gains (Table 5)                                                       | 76.8466   | 74.5581   | 69.8059   | 63.3420   | 59.1438   | 53.2351   | 48.2161   | 54.6503   | 56.9390   | 63.6289   | 71.1796   | 74.5677 (72)   |
| Total internal gains                                                                | 623.5025  | 618.8217  | 594.7930  | 557.3337  | 518.7264  | 484.2145  | 464.0628  | 472.8894  | 494.4546  | 532.1398  | 574.0997  | 606.0909 (73)  |

#### 6. Solar gains

| [Jan]       |          |           |           |           | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d |           | Gains<br>W    |               |
|-------------|----------|-----------|-----------|-----------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|-----------|---------------|---------------|
| North       |          |           |           |           | 13.3500    | 14.6401                        | 0.7200                            | 0.7000                             | 0.7700                       |           | 68.2635 (74)  |               |
| East        |          |           |           |           | 1.8900     | 27.3735                        | 0.7200                            | 0.7000                             | 0.7700                       |           | 18.0699 (76)  |               |
| South       |          |           |           |           | 9.9500     | 61.3950                        | 0.7200                            | 0.7000                             | 0.7700                       |           | 213.3633 (78) |               |
|             |          |           |           |           |            |                                |                                   |                                    |                              |           |               |               |
| Solar gains | 299.6966 | 430.1429  | 606.4965  | 825.7524  | 942.0684   | 1028.8248                      | 975.4420                          | 860.1272                           | 720.0665                     | 516.0421  | 344.7554      | 248.5231 (83) |
| Total gains | 923.1992 | 1048.9646 | 1201.2895 | 1383.0861 | 1460.7948  | 1513.0394                      | 1439.5048                         | 1333.0166                          | 1214.5211                    | 1048.1820 | 918.8551      | 854.6140 (84) |

#### 7. Mean internal temperature (heating season)

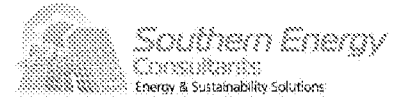
|                                                                             |         |         |         |         |         |         |         |         |         |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|--------------|
| Temperature during heating periods in the living area from Table 9, Th1 (C) |         |         |         |         |         |         |         |         |         |         |         | 21.0000 (85) |
| Utilisation factor for gains for living area, nil,m (see Table 9a)          |         |         |         |         |         |         |         |         |         |         |         |              |
| tau                                                                         | 50.8881 | 51.6631 | 52.1037 | 52.5244 | 52.2462 | 52.9242 | 52.6601 | 52.9242 | 52.6601 | 52.1037 | 51.9590 | 51.6631      |
| alpha                                                                       | 4.3925  | 4.4442  | 4.4736  | 4.5016  | 4.4831  | 4.5283  | 4.5107  | 4.5283  | 4.5107  | 4.4736  | 4.4639  | 4.4442       |
| util living area                                                            | 0.9829  | 0.9713  | 0.9355  | 0.8387  | 0.6680  | 0.4531  | 0.3142  | 0.3183  | 0.5553  | 0.8414  | 0.9605  | 0.9864 (86)  |
| MIT                                                                         | 19.9591 | 20.1107 | 20.4031 | 20.7255 | 20.9231 | 20.9894 | 20.9984 | 20.9985 | 20.9759 | 20.7853 | 20.3583 | 19.9485 (87) |
| Th 2                                                                        | 19.7905 | 19.8064 | 19.8152 | 19.8235 | 19.8180 | 19.8313 | 19.8262 | 19.8313 | 19.8262 | 19.8152 | 19.8123 | 19.8064 (88) |
| util rest of house                                                          | 0.9770  | 0.9619  | 0.9149  | 0.7932  | 0.5895  | 0.3586  | 0.2095  | 0.2062  | 0.4444  | 0.7792  | 0.9444  | 0.9815 (89)  |
| MIT 2                                                                       | 18.4771 | 18.7036 | 19.1177 | 19.5436 | 19.7594 | 19.8266 | 19.8259 | 19.8311 | 19.8148 | 19.6227 | 19.0636 | 18.4738 (90) |
| Living area fraction                                                        | 18.7619 | 18.9740 | 19.3647 | 19.7707 | 19.9830 | 20.0501 | 20.0512 | 20.0554 | 20.0379 | 19.8461 | 19.3124 | 18.7571 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |         |         |         | -0.1500      |
| adjusted MIT                                                                | 18.6119 | 18.8240 | 19.2147 | 19.6207 | 19.8330 | 19.9001 | 19.9012 | 19.9054 | 19.8879 | 19.6961 | 19.1624 | 18.6071 (93) |

#### 8. Space heating requirement

|                          | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec            |
|--------------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------|
| Utilisation              | 0.9688    | 0.9513    | 0.9018    | 0.7842    | 0.5906   | 0.3643   | 0.2162   | 0.2134   | 0.4505   | 0.7718   | 0.9325    | 0.9743 (94)    |
| Useful gains             | 894.3725  | 997.8792  | 1083.3556 | 1084.6126 | 862.7293 | 551.2179 | 311.2166 | 284.4303 | 547.1622 | 809.0137 | 856.8708  | 832.6465 (95)  |
| Ext temp.                | 5.8000    | 6.0000    | 7.5000    | 9.8000    | 12.9000  | 15.6000  | 17.5000  | 17.7000  | 15.6000  | 12.5000  | 9.0000    | 6.0000 (96)    |
| Heat loss rate W         | 1719.6987 | 1695.5053 | 1535.7437 | 1277.1348 | 906.4115 | 554.9773 | 311.4614 | 284.6362 | 556.1821 | 943.3756 | 1335.9508 | 1666.8306 (97) |
| Month fracti             | 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 kWh        | 614.0427  | 468.8047  | 336.5767  | 138.6159  | 32.4996  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 99.9652  | 344.9376  | 620.6330 (98)  |
| Space heating            |           |           |           |           |          |          |          |          |          |          |           | 2656.0754 (98) |
| RHI space heating demand |           |           |           |           |          |          |          |          |          |          |           | 2656 (98)      |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF ENERGY RATINGS 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF ENERGY RATINGS 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                                           | 51.9700 (1b)              | x 2.3500 (2b)                     | = 122.1295 (1b) - (3b)      |
| First floor                                            | 46.3900 (1c)              | x 2.6500 (2c)                     | = 122.9335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 98.3600                   |                                   | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) = | 245.0630 (5)                |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other                       | total           | m3 per hour           |
|---------------------------------------------------------------------------|-----------------|----------------------|-----------------------------|-----------------|-----------------------|
| Number of chimneys                                                        | 0               | +                    | 0                           | =               | 0 * 40 = 0.0000 (6a)  |
| Number of open flues                                                      | 0               | +                    | 0                           | =               | 0 * 20 = 0.0000 (6b)  |
| Number of intermittent fans                                               |                 |                      |                             |                 | 5 * 10 = 50.0000 (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) = |                 |                      |                             | 50.0000 / (5) = | 0.2040 (8)            |
| Pressure test                                                             |                 |                      |                             |                 | Yes                   |
| Measured/design AP50                                                      |                 |                      |                             |                 | 5.0000                |
| Infiltration rate                                                         |                 |                      |                             |                 | 0.4540 (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) =        |                 | 0.3859 (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 | 0.4921 | 0.4824 | 0.4728 | 0.4245 | 0.4149 | 0.3666 | 0.3666 | 0.3570 | 0.3859 | 0.4149 | 0.4342 | 0.4535 (22b) |
| Effective ac    | 0.6211 | 0.6164 | 0.6118 | 0.5901 | 0.5861 | 0.5672 | 0.5672 | 0.5637 | 0.5745 | 0.5861 | 0.5942 | 0.6028 (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                                                      |               |                | 1.9500                | 1.5000           | 2.9250        |                   | (26)          |               |               |               |               |                    |
| Opening Type 2 (Uw = 1.30)                                          |               |                | 25.1900               | 1.2357           | 31.1283       |                   | (27)          |               |               |               |               |                    |
| Heat Loss Floor 1                                                   |               |                | 51.9700               | 0.1500           | 7.7955        |                   | (28a)         |               |               |               |               |                    |
| External Wall 1                                                     | 144.8800      | 27.1400        | 117.7400              | 0.2400           | 28.2576       |                   | (29a)         |               |               |               |               |                    |
| External Roof 1                                                     | 51.9700       |                | 51.9700               | 0.1100           | 5.7167        |                   | (30)          |               |               |               |               |                    |
| Total net area of external elements Aum(A, m2)                      |               |                | 248.8200              |                  |               |                   | (31)          |               |               |               |               |                    |
| Fabric heat loss, W/K = Sum (A x U)                                 |               |                | (26)... (30) + (32) = |                  | 75.8231       |                   | (33)          |               |               |               |               |                    |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |               |                |                       |                  |               |                   | 250.0000 (35) |               |               |               |               |                    |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |               |                |                       |                  |               |                   | 6.1647 (36)   |               |               |               |               |                    |
| Total fabric heat loss                                              |               |                |                       |                  |               | (33) + (36) =     | 81.9878 (37)  |               |               |               |               |                    |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |               |                |                       |                  |               |                   |               |               |               |               |               |                    |
| (38)m                                                               | 50.2255       | 49.8453        | 49.4727               | 47.7225          | 47.3950       | 45.8706           | 45.8706       | 45.5883       | 46.4578       | 47.3950       | 48.0575       | 48.7500 (38)       |
| Heat transfer coeff                                                 | 132.2133      | 131.8332       | 131.4605              | 129.7103         | 129.3828      | 127.8584          | 127.8584      | 127.5761      | 128.4456      | 129.3828      | 130.0453      | 130.7378 (39)      |
| Average = Sum(39)m / 12 =                                           |               |                |                       |                  |               |                   |               |               |               |               |               | 129.7087 (39)      |
| HLP                                                                 | Jan<br>1.3442 | Feb<br>1.3403  | Mar<br>1.3365         | Apr<br>1.3187    | May<br>1.3154 | Jun<br>1.2999     | Jul<br>1.2999 | Aug<br>1.2970 | Sep<br>1.3059 | Oct<br>1.3154 | Nov<br>1.3221 | Dec<br>1.3292 (40) |
| HLP (average)                                                       |               |                |                       |                  |               |                   |               |               |               |               |               | 1.3187 (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                            |          |          |          |          |          |          |         |          |          |                    |          | 2.7238 (42)    |
| Average daily hot water use (litres/day)     |          |          |          |          |          |          |         |          |          |                    |          | 98.8906 (43)   |
| Daily hot water use                          | 108.7797 | 104.8241 | 100.8685 | 96.9128  | 92.9572  | 89.0016  | 89.0016 | 92.9572  | 96.9128  | 100.8685           | 104.8241 | 108.7797 (44)  |
| Energy conte                                 | 161.3172 | 141.0890 | 145.5912 | 126.9300 | 121.7923 | 105.0975 | 97.3883 | 111.7545 | 113.0892 | 131.7946           | 143.8641 | 156.2271 (45)  |
| Energy content (annual)                      |          |          |          |          |          |          |         |          |          | Total = Sum(45)m = |          | 1555.9348 (45) |
| Distribution loss (46)m = 0.15 x (45)m       | 24.1976  | 21.1634  | 21.8387  | 19.0395  | 18.2688  | 15.7646  | 14.6082 | 16.7632  | 16.9634  | 19.7692            | 21.5796  | 23.4341 (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 ENERGY RATINGS 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 | 14.1437  | 12.7639  | 14.1060  | 13.6080  | 14.0283  | 13.5373  | 13.9646  | 14.0059  | 13.5758  | 14.0729  | 13.6581  | 14.1315 (61)  |
| Solar input                                                     | 175.4609 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674 | 157.5221 | 170.3586 (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                        | 175.4609 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674 | 157.5221 | 170.3586 (64) |
|                                                                 | 57.1739  | 50.1031  | 51.9356  | 45.6062  | 44.0030  | 38.3292  | 35.8728  | 40.6598  | 40.9961  | 47.3399  | 51.2493  | 55.4784 (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                                                                               | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 56.5325   | 50.2116   | 40.8348   | 30.9146   | 23.1090   | 19.5096   | 21.0808   | 27.4017   | 36.7784   | 46.6987   | 54.5043   | 58.1037   | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 378.5804  | 382.5089  | 372.6093  | 351.5341  | 324.9305  | 299.9268  | 283.2229  | 279.2944  | 289.1940  | 310.2692  | 336.8728  | 361.8764  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | (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)                                 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | (71) |
| Water heating gains (Table 5)                                                       | 76.8466   | 74.5581   | 69.8059   | 63.3420   | 59.1438   | 53.2351   | 48.2161   | 54.6503   | 56.9390   | 63.6289   | 71.1796   | 74.5677   | (72) |
| Total internal gains                                                                | 623.5025  | 618.8217  | 594.7930  | 557.3337  | 518.7264  | 484.2145  | 464.0628  | 472.8894  | 494.4546  | 532.1398  | 574.0997  | 606.0909  | (73) |

#### 6. Solar gains

| [Jan]       |          |           |           |           | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d |          | Gains<br>W    |               |
|-------------|----------|-----------|-----------|-----------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|----------|---------------|---------------|
| North       |          |           |           |           | 13.3500    | 10.6334                        | 0.7200                            | 0.7000                             | 0.7700                       |          | 49.5812 (74)  |               |
| East        |          |           |           |           | 1.8900     | 19.6403                        | 0.7200                            | 0.7000                             | 0.7700                       |          | 12.9650 (76)  |               |
| South       |          |           |           |           | 9.9500     | 46.7521                        | 0.7200                            | 0.7000                             | 0.7700                       |          | 162.4754 (78) |               |
| Solar gains | 225.0216 | 386.2073  | 541.7303  | 702.6278  | 822.2447   | 833.5592                       | 796.3274                          | 703.2859                           | 596.2394                     | 429.8907 | 269.9194      | 192.3888 (83) |
| Total gains | 848.5241 | 1005.0291 | 1136.5233 | 1259.9615 | 1340.9711  | 1317.7737                      | 1260.3902                         | 1176.1753                          | 1090.6939                    | 962.0305 | 844.0191      | 798.4797 (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                                                                         | 51.6631 | 51.8121 | 51.9590 | 52.6601 | 52.7934 | 53.4228 | 53.4228 | 53.5410 | 53.1786 | 52.7934 | 52.5244 | 52.2462 |              |
| alpha                                                                       | 4.4442  | 4.4541  | 4.4639  | 4.5107  | 4.5196  | 4.5615  | 4.5615  | 4.5694  | 4.5452  | 4.5196  | 4.5016  | 4.4831  |              |
| util living area                                                            | 0.9912  | 0.9808  | 0.9573  | 0.8957  | 0.7719  | 0.5922  | 0.4400  | 0.4883  | 0.7258  | 0.9258  | 0.9824  | 0.9932  | (86)         |
| MIT                                                                         | 19.7394 | 19.9510 | 20.2445 | 20.5915 | 20.8441 | 20.9647 | 20.9926 | 20.9884 | 20.9122 | 20.5783 | 20.0942 | 19.7024 | (87)         |
| Th 2                                                                        | 19.8064 | 19.8094 | 19.8123 | 19.8262 | 19.8288 | 19.8409 | 19.8409 | 19.8432 | 19.8362 | 19.8288 | 19.8235 | 19.8180 | (88)         |
| util rest of house                                                          | 0.9883  | 0.9747  | 0.9436  | 0.8631  | 0.7079  | 0.4968  | 0.3274  | 0.3709  | 0.6339  | 0.8949  | 0.9757  | 0.9909  | (89)         |
| MIT 2                                                                       | 18.1699 | 18.4768 | 18.8959 | 19.3789 | 19.6897 | 19.8199 | 19.8385 | 19.8390 | 19.7746 | 19.3766 | 18.6966 | 18.1243 | (90)         |
| Living area fraction                                                        | 18.4715 | 18.7600 | 19.1550 | 19.6119 | 19.9115 | 20.0399 | 20.0603 | 20.0598 | 19.9932 | 19.6075 | 18.9652 | 18.4275 | (91)         |
| MIT                                                                         | 18.4715 | 18.7600 | 19.1550 | 19.6119 | 19.9115 | 20.0399 | 20.0603 | 20.0598 | 19.9932 | 19.6075 | 18.9652 | 18.4275 | (92)         |
| Temperature adjustment                                                      | 18.3215 | 18.6100 | 19.0050 | 19.4619 | 19.7615 | 19.8899 | 19.9103 | 19.9098 | 19.8432 | 19.4575 | 18.8152 | 18.2775 | (93)         |

#### 8. Space heating requirement

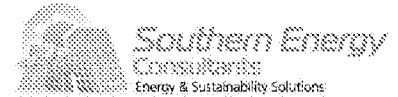
|                      |           |           |           |           |           |          |          |          |          |           |           |           |       |
|----------------------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|-----------|-----------|-------|
| Utilisation          | Jan       | Feb       | Mar       | Apr       | May       | Jun      | Jul      | Aug      | Sep      | Oct       | Nov       | Dec       |       |
| Useful gains         | 834.0460  | 970.9669  | 1058.6315 | 1072.2739 | 943.7863  | 660.2528 | 421.3073 | 444.3942 | 692.1047 | 848.9613  | 816.5875  | 787.6696  | (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     | 1853.8291 | 1807.4391 | 1643.9157 | 1369.9830 | 1043.0209 | 676.3567 | 423.2488 | 447.7708 | 737.6834 | 1146.0088 | 1523.5001 | 1840.4674 | (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    | 758.7186  | 562.1093  | 435.4514  | 214.3506  | 73.8305   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 221.0033  | 508.9771  | 783.2815  | (98)  |
| Space heating        |           |           |           |           |           |          |          |          |          |           |           | 3557.7225 | (98)  |
| Space heating per m2 |           |           |           |           |           |          |          |          |          |           |           | 36.1704   | (99)  |

#### 8c. Space cooling requirement

Not applicable

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF ENERGY RATINGS 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                                             |          |          |          |          |          |          |          |          |          |           |          |           | 3931.1851 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct       | Nov      | Dec       |                 |
| Space heating requirement                                             | 758.7186 | 562.1093 | 435.4514 | 214.3506 | 73.8305  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 221.0033  | 508.9771 | 783.2815  | (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)                              | 838.3631 | 621.1153 | 481.1618 | 236.8515 | 81.5807  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 244.2026  | 562.4057 | 865.5045  | (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                                             | 175.4609 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674  | 157.5221 | 170.3586  | (64)            |
| Efficiency of water heater                                            | 89.8812  | 89.7927  | 89.6185  | 89.2051  | 88.4008  | 87.3000  | 87.3000  | 87.3000  | 87.3000  | 89.2000   | 89.7227  | 89.9113   | (216)           |
| (217)m                                                                |          |          |          |          |          |          |          |          |          |           |          |           | (217)           |
| Fuel for water heating, kWh/month                                     | 195.2142 | 171.3423 | 178.1966 | 157.5447 | 153.6419 | 135.8932 | 127.5520 | 144.0554 | 145.0917 | 163.5285  | 175.5655 | 189.4741  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |           |          | 1937.1002 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |           |          | 3931.1851 | (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)                   |          |          |          |          |          |          |          |          |          |           |          | 399.3523  | (232)           |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| PV Unit 0 (0.80 * 0.75 * 1080 * 0.80) =                               |          |          |          |          |          |          |          |          |          | -518.1718 |          | -518.1718 | (233)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |           |          | 5824.4658 | (238)           |

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

|                                       | Fuel<br>kWh/year | Fuel price<br>p/kWh | Fuel cost<br>£/year |
|---------------------------------------|------------------|---------------------|---------------------|
| Space heating - main system 1         | 3931.1851        | 3.4800              | 136.8052 (240)      |
| Space heating - secondary             | 0.0000           | 0.0000              | 0.0000 (242)        |
| Water heating (other fuel)            | 1937.1002        | 3.4800              | 67.4111 (247)       |
| Pumps and fans for heating            | 75.0000          | 13.1900             | 9.8925 (249)        |
| Energy for lighting                   | 399.3523         | 13.1900             | 52.6746 (250)       |
| Additional standing charges           |                  |                     | 120.0000 (251)      |
| Energy saving/generation technologies |                  |                     |                     |
| PV Unit                               | -518.1718        | 13.1900             | -68.3469 (252)      |
| Total energy cost                     |                  |                     | 318.4365 (255)      |

#### 11a. SAP rating - Individual heating systems

|                                  |              |
|----------------------------------|--------------|
| Energy cost deflator (Table 12): | 0.4200 (256) |
| Energy cost factor (ECF)         | 0.9329 (257) |
| SAP value                        | 86.9858      |
| SAP rating (Section 12)          | 87 (258)     |
| SAP band                         | B            |

#### 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         | 3931.1851          | 0.2160                        | 849.1360 (261)           |
| Space heating - secondary             | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)            | 1937.1002          | 0.2160                        | 418.4136 (264)           |
| Space and water heating               |                    |                               | 1267.5496 (265)          |
| Pumps and fans                        | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                   | 399.3523           | 0.5190                        | 207.2639 (268)           |
| Energy saving/generation technologies |                    |                               |                          |
| PV Unit                               | -518.1718          | 0.5190                        | -268.9312 (269)          |
| Total kg/year                         |                    |                               | 1244.8073 (272)          |
| CO2 emissions per m2                  |                    |                               | 12.6600 (273)            |
| EI value                              |                    |                               | 88.3647                  |
| EI rating                             |                    |                               | 88 (274)                 |
| EI band                               |                    |                               | B                        |

#### Calculation of stars for heating and DHW

|                                    |                                                                     |
|------------------------------------|---------------------------------------------------------------------|
| Main heating energy efficiency     | $3.48 \times (1 + 0.29 \times 0.00) / 0.9050 = 3.845$ , stars = 4   |
| Main heating environmental impact  | $0.216 \times (1 + 0.29 \times 0.00) / 0.9050 = 0.2387$ , stars = 4 |
| Water heating energy efficiency    | $3.48 / 0.8874 = 3.921$ , stars = 4                                 |
| Water heating environmental impact | $0.216 / 0.8874 = 0.2434$ , stars = 4                               |

# FULL SAP CALCULATION PRINTOUT

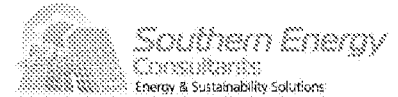
## Calculation Type: New Build (As Designed)



CALCULATION OF ENERGY RATINGS 09 Jan 2014

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 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                                           | 51.9700 (1b)              | x 2.3500 (2b)                   | = 122.1295 (1b) - (3b)      |
| First floor                                            | 46.3900 (1c)              | x 2.6500 (2c)                   | = 122.9335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 98.3600                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 245.0630 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other | total                       | m <sup>3</sup> per hour    |
|---------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                               |                 |                      |       |                             | 5 * 10 = 50.0000 (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) = |                 |                      |       |                             | 50.0000 / (5) = 0.2040 (8) |
| Pressure test                                                             |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                      |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                         |                 |                      |       |                             | 0.4540 (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) =        | 0.3859 (21)                |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.6000 | 5.1000 | 4.8000 | 4.5000 | 4.7000 | 4.2000 | 4.4000 | 4.2000 | 4.4000 | 4.8000 | 4.9000 | 5.1000 (22)  |
| Wind factor     | 1.4000 | 1.2750 | 1.2000 | 1.1250 | 1.1750 | 1.0500 | 1.1000 | 1.0500 | 1.1000 | 1.2000 | 1.2250 | 1.2750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac    | 0.5403 | 0.4921 | 0.4631 | 0.4342 | 0.4535 | 0.4052 | 0.4245 | 0.4052 | 0.4245 | 0.4631 | 0.4728 | 0.4921 (22b) |
|                 | 0.6460 | 0.6211 | 0.6072 | 0.5942 | 0.6028 | 0.5821 | 0.5901 | 0.5821 | 0.5901 | 0.6072 | 0.6118 | 0.6211 (25)  |

#### 3. Heat losses and heat loss parameter

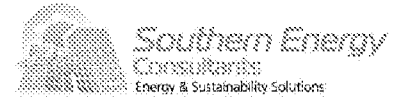
| Element                                                             | Gross<br>m2   | Openings<br>m2 | NetArea<br>m2        | U-value<br>W/m2K | A x U<br>W/K  | K-value<br>kJ/m2K | A x K<br>kJ/K |               |               |               |               |                    |
|---------------------------------------------------------------------|---------------|----------------|----------------------|------------------|---------------|-------------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| Opening Type 1                                                      |               |                | 1.9500               | 1.5000           | 2.9250        |                   | (26)          |               |               |               |               |                    |
| Opening Type 2 (Uw = 1.30)                                          |               |                | 25.1900              | 1.2357           | 31.1283       |                   | (27)          |               |               |               |               |                    |
| Heat Loss Floor 1                                                   |               |                | 51.9700              | 0.1500           | 7.7955        |                   | (28a)         |               |               |               |               |                    |
| External Wall 1                                                     | 144.8800      | 27.1400        | 117.7400             | 0.2400           | 28.2576       |                   | (29a)         |               |               |               |               |                    |
| External Roof 1                                                     | 51.9700       |                | 51.9700              | 0.1100           | 5.7167        |                   | (30)          |               |               |               |               |                    |
| Total net area of external elements Aum(A, m2)                      |               |                | 248.8200             |                  |               |                   | (31)          |               |               |               |               |                    |
| Fabric heat loss, W/K = Sum (A x U)                                 |               |                | (26)...(30) + (32) = |                  | 75.8231       |                   | (33)          |               |               |               |               |                    |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |               |                |                      |                  |               |                   | 250.0000 (35) |               |               |               |               |                    |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |               |                |                      |                  |               |                   | 6.1647 (36)   |               |               |               |               |                    |
| Total fabric heat loss                                              |               |                |                      |                  |               | (33) + (36) =     | 81.9878 (37)  |               |               |               |               |                    |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |               |                |                      |                  |               |                   |               |               |               |               |               |                    |
| (38)m                                                               | 52.2392       | 50.2255        | 49.1076              | 48.0575          | 48.7500       | 47.0751           | 47.7225       | 47.0751       | 47.7225       | 49.1076       | 49.4727       | 50.2255 (38)       |
| Heat transfer coeff                                                 | 134.2271      | 132.2133       | 131.0954             | 130.0453         | 130.7378      | 129.0629          | 129.7103      | 129.0629      | 129.7103      | 131.0954      | 131.4605      | 132.2133 (39)      |
| Average = Sum(39)m / 12 =                                           |               |                |                      |                  |               |                   |               |               |               |               |               | 130.8862 (39)      |
| HLP                                                                 | Jan<br>1.3647 | Feb<br>1.3442  | Mar<br>1.3328        | Apr<br>1.3221    | May<br>1.3292 | Jun<br>1.3121     | Jul<br>1.3187 | Aug<br>1.3121 | Sep<br>1.3187 | Oct<br>1.3328 | Nov<br>1.3365 | Dec<br>1.3442 (40) |
| HLP (average)                                                       |               |                |                      |                  |               |                   |               |               |               |               |               | 1.3307 (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                            |          |          |          |          |          |          |         |          |          |                    |          | 2.7238 (42)    |
| Average daily hot water use (litres/day)     |          |          |          |          |          |          |         |          |          |                    |          | 98.8906 (43)   |
| Daily hot water use                          | 108.7797 | 104.8241 | 100.8685 | 96.9128  | 92.9572  | 89.0016  | 89.0016 | 92.9572  | 96.9128  | 100.8685           | 104.8241 | 108.7797 (44)  |
| Energy conte                                 | 161.3172 | 141.0890 | 145.5912 | 126.9300 | 121.7923 | 105.0975 | 97.3883 | 111.7545 | 113.0892 | 131.7946           | 143.8641 | 156.2271 (45)  |
| Energy content (annual)                      |          |          |          |          |          |          |         |          |          | Total = Sum(45)m = |          | 1555.9348 (45) |
| Distribution loss (46)m = 0.15 x (45)m       |          |          |          |          |          |          |         |          |          |                    |          |                |
|                                              | 24.1976  | 21.1634  | 21.8387  | 19.0395  | 18.2688  | 15.7646  | 14.6082 | 16.7632  | 16.9634  | 19.7692            | 21.5796  | 23.4341 (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 EPC Costs, Emissions and Primary Energy 09 Jan 2014

|                                                                 |                                          |          |          |          |          |          |          |          |          |          |          |                |
|-----------------------------------------------------------------|------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------------|
|                                                                 | 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                                                      | 14.1437                                  | 12.7639  | 14.1060  | 13.6080  | 14.0283  | 13.5373  | 13.9646  | 14.0059  | 13.5758  | 14.0729  | 13.6581  | 14.1315 (61)   |
| Total heat required for water heating calculated for each month |                                          |          |          |          |          |          |          |          |          |          |          |                |
|                                                                 | 175.4609                                 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674 | 157.5221 | 170.3586 (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                                                 | 175.4609                                 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674 | 157.5221 | 170.3586 (64)  |
|                                                                 | Total per year (kWh/year) = Sum(64)m =   |          |          |          |          |          |          |          |          |          |          | 1721.5308 (64) |
| Heat gains from water heating, kWh/month                        |                                          |          |          |          |          |          |          |          |          |          |          |                |
|                                                                 | 57.1739                                  | 50.1031  | 51.9356  | 45.6062  | 44.0030  | 38.3292  | 35.8728  | 40.6598  | 40.9961  | 47.3399  | 51.2493  | 55.4784 (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                                                                               | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 56.5325   | 50.2116   | 40.8348   | 30.9146   | 23.1090   | 19.5096   | 21.0808   | 27.4017   | 36.7784   | 46.6987   | 54.5043   | 58.1037 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 378.5804  | 382.5089  | 372.6093  | 351.5341  | 324.9305  | 299.9268  | 283.2229  | 279.2944  | 289.1940  | 310.2692  | 336.8728  | 361.8764 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667 (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)                                 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 (71) |
| Water heating gains (Table 5)                                                       |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 76.8466   | 74.5581   | 69.8059   | 63.3420   | 59.1438   | 53.2351   | 48.2161   | 54.6503   | 56.9390   | 63.6289   | 71.1796   | 74.5677 (72)   |
| Total internal gains                                                                |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 623.5025  | 618.8217  | 594.7930  | 557.3337  | 518.7264  | 484.2145  | 464.0628  | 472.8894  | 494.4546  | 532.1398  | 574.0997  | 606.0909 (73)  |

#### 6. Solar gains

| [Jan]       | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W    |
|-------------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|---------------|
| North       | 13.3500    | 14.6401                        | 0.7200                            | 0.7000                             | 0.7700                       | 68.2635 (74)  |
| East        | 1.8900     | 27.3735                        | 0.7200                            | 0.7000                             | 0.7700                       | 18.0699 (76)  |
| South       | 9.9500     | 61.3950                        | 0.7200                            | 0.7000                             | 0.7700                       | 213.3633 (78) |
| Solar gains |            |                                |                                   |                                    |                              |               |
|             | 299.6966   | 430.1429                       | 606.4965                          | 825.7524                           | 942.0684                     | 1028.8248     |
| Total gains |            |                                |                                   |                                    |                              |               |
|             | 923.1992   | 1048.9646                      | 1201.2895                         | 1383.0861                          | 1460.7948                    | 1513.0394     |

#### 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                                                                         | 50.8881                   | 51.6631 | 52.1037 | 52.5244 | 52.2462 | 52.9242 | 52.6601 | 52.9242 | 52.6601 | 52.1037 | 51.9590 | 51.6631      |
| alpha                                                                       | 4.3925                    | 4.4442  | 4.4736  | 4.5016  | 4.4831  | 4.5283  | 4.5107  | 4.5283  | 4.5107  | 4.4736  | 4.4639  | 4.4442       |
| util living area                                                            |                           |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 0.9829                    | 0.9713  | 0.9355  | 0.8387  | 0.6680  | 0.4531  | 0.3142  | 0.3183  | 0.5553  | 0.8414  | 0.9605  | 0.9864 (86)  |
| MIT                                                                         |                           |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 19.9591                   | 20.1107 | 20.4031 | 20.7255 | 20.9231 | 20.9894 | 20.9984 | 20.9985 | 20.9759 | 20.7853 | 20.3583 | 19.9485 (87) |
| Th 2                                                                        | 19.7905                   | 19.8064 | 19.8152 | 19.8235 | 19.8180 | 19.8313 | 19.8262 | 19.8313 | 19.8262 | 19.8152 | 19.8123 | 19.8064 (88) |
| util rest of house                                                          |                           |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 0.9770                    | 0.9619  | 0.9149  | 0.7932  | 0.5895  | 0.3586  | 0.2095  | 0.2062  | 0.4444  | 0.7792  | 0.9444  | 0.9815 (89)  |
| MIT 2                                                                       | 18.4771                   | 18.7036 | 19.1177 | 19.5436 | 19.7594 | 19.8266 | 19.8259 | 19.8311 | 19.8148 | 19.6227 | 19.0636 | 18.4738 (90) |
| Living area fraction                                                        |                           |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | fLA = Living area / (4) = |         |         |         |         |         |         |         |         |         |         |              |
|                                                                             | 0.1922 (91)               |         |         |         |         |         |         |         |         |         |         |              |
| MIT                                                                         | 18.7619                   | 18.9740 | 19.3647 | 19.7707 | 19.9830 | 20.0501 | 20.0512 | 20.0554 | 20.0379 | 19.8461 | 19.3124 | 18.7571 (92) |
| Temperature adjustment                                                      |                           |         |         |         |         |         |         |         |         |         |         |              |
| adjusted MIT                                                                | 18.6119                   | 18.8240 | 19.2147 | 19.6207 | 19.8330 | 19.9001 | 19.9012 | 19.9054 | 19.8879 | 19.6961 | 19.1624 | 18.6071 (93) |
|                                                                             | -0.1500                   |         |         |         |         |         |         |         |         |         |         |              |

#### 8. Space heating requirement

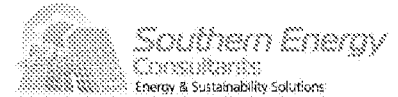
|                   |              |           |           |           |          |          |          |          |          |          |           |                |
|-------------------|--------------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------|
|                   | Jan          | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec            |
| Utilisation       | 0.9688       | 0.9513    | 0.9018    | 0.7842    | 0.5906   | 0.3643   | 0.2162   | 0.2134   | 0.4505   | 0.7718   | 0.9325    | 0.9743 (94)    |
| Useful gains      | 894.3725     | 997.8792  | 1083.3556 | 1084.6126 | 862.7293 | 551.2179 | 311.2166 | 284.4303 | 547.1622 | 809.0137 | 856.8708  | 832.6465 (95)  |
| Ext temp.         | 5.8000       | 6.0000    | 7.5000    | 9.8000    | 12.9000  | 15.6000  | 17.5000  | 17.7000  | 15.6000  | 12.5000  | 9.0000    | 6.0000 (96)    |
| Heat loss rate W  |              |           |           |           |          |          |          |          |          |          |           |                |
|                   | 1719.6987    | 1695.5053 | 1535.7437 | 1277.1348 | 906.4115 | 554.9773 | 311.4614 | 284.6362 | 556.1821 | 943.3756 | 1335.9508 | 1666.8306 (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 |              |           |           |           |          |          |          |          |          |          |           |                |
|                   | 614.0427     | 468.8047  | 336.5767  | 138.6159  | 32.4996  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 99.9652  | 344.9376  | 620.6330 (98)  |
| Space heating     |              |           |           |           |          |          |          |          |          |          |           |                |
|                   | (98) / (4) = |           |           |           |          |          |          |          |          |          |           | 27.0036 (99)   |

#### 8c. Space cooling requirement

Not applicable

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### Calculation of EPC Costs, Emissions and Primary Energy 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                                             |          |          |          |          |          |          |          |          |          |           |          |           | 2934.8900 (211) |
|                                                                       | Jan      | Feb      | Mar      | Apr      | May      | Jun      | Jul      | Aug      | Sep      | Oct       | Nov      | Dec       |                 |
| Space heating requirement                                             | 614.0427 | 468.8047 | 336.5767 | 138.6159 | 32.4996  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 99.9652   | 344.9376 | 620.6330  | (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)                              | 678.5002 | 518.0163 | 371.9080 | 153.1668 | 35.9111  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 110.4588  | 381.1465 | 685.7823  | (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                                             | 175.4609 | 153.8529 | 159.6972 | 140.5380 | 135.8206 | 118.6348 | 111.3529 | 125.7604 | 126.6650 | 145.8674  | 157.5221 | 170.3586  | (64)            |
| Efficiency of water heater                                            | 89.7687  | 89.6877  | 89.4450  | 88.8602  | 87.9001  | 87.3000  | 87.3000  | 87.3000  | 87.3000  | 88.5735   | 89.4718  | 87.3000   | (216)           |
| (217)m                                                                | 89.7687  | 89.6877  | 89.4450  | 88.8602  | 87.9001  | 87.3000  | 87.3000  | 87.3000  | 87.3000  | 88.5735   | 89.4718  | 89.7911   | (217)           |
| Fuel for water heating, kWh/month                                     | 195.4588 | 171.5430 | 178.5424 | 158.1563 | 154.5170 | 135.8932 | 127.5520 | 144.0554 | 145.0917 | 164.6851  | 176.0578 | 189.7276  | (219)           |
| Water heating fuel used                                               |          |          |          |          |          |          |          |          |          |           |          | 1941.2802 | (219)           |
| Annual totals kWh/year                                                |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| Space heating fuel - main system                                      |          |          |          |          |          |          |          |          |          |           |          | 2934.8900 | (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)                   |          |          |          |          |          |          |          |          |          |           |          | 399.3523  | (232)           |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |          |          |          |          |          |           |          |           |                 |
| PV Unit 0 (0.80 * 0.75 * 1307 * 0.80) =                               |          |          |          |          |          |          |          |          |          | -627.3276 |          | -627.3276 | (233)           |
| Total delivered energy for all uses                                   |          |          |          |          |          |          |          |          |          |           |          | 4723.1949 | (238)           |

#### 10a. Fuel costs - using BEDF prices (491)

|                                       | Fuel<br>kWh/year | Fuel price<br>p/kWh | Fuel cost<br>£/year |
|---------------------------------------|------------------|---------------------|---------------------|
| Space heating - main system 1         | 2934.8900        | 3.6300              | 106.5365 (240)      |
| Space heating - secondary             | 0.0000           | 0.0000              | 0.0000 (242)        |
| Water heating (other fuel)            | 1941.2802        | 3.6300              | 70.4685 (247)       |
| Pumps and fans for heating            | 75.0000          | 19.4400             | 14.5800 (249)       |
| Energy for lighting                   | 399.3523         | 19.4400             | 77.6341 (250)       |
| Additional standing charges           |                  |                     | 95.0000 (251)       |
| Energy saving/generation technologies |                  |                     |                     |
| PV Unit                               | -627.3276        | 19.4400             | -121.9525 (252)     |
| Total energy cost                     |                  |                     | 242.2666 (255)      |

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

|                                       | Energy<br>kWh/year | Emission factor<br>kg CO2/kWh | Emissions<br>kg CO2/year |
|---------------------------------------|--------------------|-------------------------------|--------------------------|
| Space heating - main system 1         | 2934.8900          | 0.2160                        | 633.9362 (261)           |
| Space heating - secondary             | 0.0000             | 0.0000                        | 0.0000 (263)             |
| Water heating (other fuel)            | 1941.2802          | 0.2160                        | 419.3165 (264)           |
| Space and water heating               |                    |                               | 1053.2528 (265)          |
| Pumps and fans                        | 75.0000            | 0.5190                        | 38.9250 (267)            |
| Energy for lighting                   | 399.3523           | 0.5190                        | 207.2639 (268)           |
| Energy saving/generation technologies |                    |                               |                          |
| PV Unit                               | -627.3276          | 0.5190                        | -325.5831 (269)          |
| Total kg/year                         |                    |                               | 973.8586 (272)           |

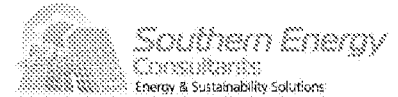
#### 13a. Primary energy - Individual heating systems including micro-CHP

|                                       | Energy<br>kWh/year | Primary energy factor<br>kg CO2/kWh | Primary energy<br>kWh/year |
|---------------------------------------|--------------------|-------------------------------------|----------------------------|
| Space heating - main system 1         | 2934.8900          | 1.2200                              | 3580.5658 (261)            |
| Space heating - secondary             | 0.0000             | 0.0000                              | 0.0000 (263)               |
| Water heating (other fuel)            | 1941.2802          | 1.2200                              | 2368.3619 (264)            |
| Space and water heating               |                    |                                     | 5948.9277 (265)            |
| Pumps and fans                        | 75.0000            | 3.0700                              | 230.2500 (267)             |
| Energy for lighting                   | 399.3523           | 3.0700                              | 1226.0117 (268)            |
| Energy saving/generation technologies |                    |                                     |                            |
| PV Unit                               | -627.3276          | 3.0700                              | -1925.8959 (269)           |
| Primary energy kWh/year               |                    |                                     | 5479.2935 (272)            |
| Primary energy kWh/m2/year            |                    |                                     | 55.7065 (273)              |

#### SAP 2012 EPC IMPROVEMENTS

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY 09 Jan 2014

Current energy efficiency rating: B 87  
Current environmental impact rating: B 88

|                             |                   |
|-----------------------------|-------------------|
| (For testing purposes):     |                   |
| A                           | Not considered    |
| B                           | Not considered    |
| C                           | Not considered    |
| D                           | Not considered    |
| E Low energy lighting       | Already installed |
| F                           | Not considered    |
| G                           | Not considered    |
| H                           | Not considered    |
| I                           | Not considered    |
| J                           | Not considered    |
| K                           | Not considered    |
| M                           | Not considered    |
| N Solar water heating       | Recommended       |
| O                           | Not considered    |
| P                           | Not considered    |
| R                           | Not considered    |
| S                           | Not considered    |
| T                           | Not considered    |
| U Solar photovoltaic panels | Already installed |
| A2                          | Not considered    |
| A3                          | Not considered    |
| T2                          | Not considered    |
| W                           | Not considered    |
| X                           | Not considered    |
| Y                           | Not considered    |
| J2                          | Not considered    |
| Q2                          | Not considered    |
| Z1                          | Not considered    |
| Z2                          | Not considered    |
| Z3                          | Not considered    |
| Z4                          | Not considered    |
| Z5                          | Not considered    |
| V2 Wind turbine             | Not applicable    |
| L2                          | Not considered    |
| Q3                          | Not considered    |
| O3                          | Not considered    |

|                       |            |             |                 |
|-----------------------|------------|-------------|-----------------|
| Recommended measures: | SAP change | Cost change | CO2 change      |
| N Solar water heating | + 1.1      | -£ 28       | -196 kg (20.2%) |

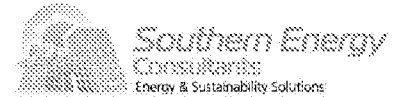
| Recommended measures                   | Typical annual savings |            | Energy efficiency | Environmental impact |
|----------------------------------------|------------------------|------------|-------------------|----------------------|
| Solar water heating                    | £28                    | 2.00 kg/m² | B 88              | B 90                 |
| Total Savings                          | £28                    | 2.00 kg/m² |                   |                      |
| Potential energy efficiency rating:    |                        |            | B 88              |                      |
| Potential environmental impact rating: |                        |            |                   | B 90                 |

Fuel prices for cost data on this page from database revision number 491 TEST (28 Feb 2022)  
Recommendation texts revision number 4.9c (22 Feb 2014)

| Typical heating and lighting costs of this home (per year, Thames Valley): |            |            |            |
|----------------------------------------------------------------------------|------------|------------|------------|
|                                                                            | Current    | Potential  | Saving     |
| Electricity                                                                | £92        | £102       | -£10       |
| Mains gas                                                                  | £272       | £235       | £37        |
| Space heating                                                              | £216       | £216       | £0         |
| Water heating                                                              | £70        | £43        | £28        |
| Lighting                                                                   | £78        | £78        | £0         |
| Generated (PV)                                                             | -£122      | -£122      | £0         |
| Total cost of fuels                                                        | £242       | £215       | £27        |
| Total cost of uses                                                         | £242       | £215       | £28        |
| Delivered energy                                                           | 48 kWh/m²  | 38 kWh/m²  | 10 kWh/m²  |
| Carbon dioxide emissions                                                   | 1.0 tonnes | 0.8 tonnes | 0.2 tonnes |
| CO2 emissions per m²                                                       | 10 kg/m²   | 8 kg/m²    | 2 kg/m²    |
| Primary energy                                                             | 56 kWh/m²  | 44 kWh/m²  | 11 kWh/m²  |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 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                                           | 51.9700 (1b)              | x 2.3500 (2b)                   | = 122.1295 (1b) - (3b)      |
| First floor                                            | 46.3900 (1c)              | x 2.6500 (2c)                   | = 122.9335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 98.3600                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 245.0630 (5)              |

#### 2. Ventilation rate

|                                                                         | main<br>heating | secondary<br>heating | other | total                       | m <sup>3</sup> per hour    |
|-------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                      | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                    | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                             |                 |                      |       |                             | 5 * 10 = 50.0000 (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) |                 |                      |       |                             | 50.0000 / (5) = 0.2040 (8) |
| Pressure test                                                           |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                    |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                       |                 |                      |       |                             | 0.4540 (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) =        | 0.3859 (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 | 0.4921 | 0.4824 | 0.4728 | 0.4245 | 0.4149 | 0.3666 | 0.3666 | 0.3570 | 0.3859 | 0.4149 | 0.4342 | 0.4535 (22b) |
| Effective ac    | 0.6211 | 0.6164 | 0.6118 | 0.5901 | 0.5861 | 0.5672 | 0.5672 | 0.5637 | 0.5745 | 0.5861 | 0.5942 | 0.6028 (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                                                      |               |                | 1.9500                | 1.5000           | 2.9250        |                   | (26)          |               |               |               |               |                    |
| Opening Type 2 (Uw = 1.30)                                          |               |                | 25.1900               | 1.2357           | 31.1283       |                   | (27)          |               |               |               |               |                    |
| Heat Loss Floor 1                                                   |               |                | 51.9700               | 0.1500           | 7.7955        |                   | (28a)         |               |               |               |               |                    |
| External Wall 1                                                     | 144.8800      | 27.1400        | 117.7400              | 0.2400           | 28.2576       |                   | (29a)         |               |               |               |               |                    |
| External Roof 1                                                     | 51.9700       |                | 51.9700               | 0.1100           | 5.7167        |                   | (30)          |               |               |               |               |                    |
| Total net area of external elements Aum(A, m2)                      |               |                | 248.8200              |                  |               |                   | (31)          |               |               |               |               |                    |
| Fabric heat loss, W/K = Sum (A x U)                                 |               |                | (26)... (30) + (32) = |                  | 75.8231       |                   | (33)          |               |               |               |               |                    |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |               |                |                       |                  |               |                   | 250.0000 (35) |               |               |               |               |                    |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |               |                |                       |                  |               |                   | 6.1647 (36)   |               |               |               |               |                    |
| Total fabric heat loss                                              |               |                |                       |                  |               | (33) + (36) =     | 81.9878 (37)  |               |               |               |               |                    |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |               |                |                       |                  |               |                   |               |               |               |               |               |                    |
| (38)m                                                               | 50.2255       | 49.8453        | 49.4727               | 47.7225          | 47.3950       | 45.8706           | 45.8706       | 45.5883       | 46.4578       | 47.3950       | 48.0575       | 48.7500 (38)       |
| Heat transfer coeff                                                 | 132.2133      | 131.8332       | 131.4605              | 129.7103         | 129.3828      | 127.8584          | 127.8584      | 127.5761      | 128.4456      | 129.3828      | 130.0453      | 130.7378 (39)      |
| Average = Sum(39)m / 12 =                                           |               |                |                       |                  |               |                   |               |               |               |               |               | 129.7087 (39)      |
| HLP                                                                 | Jan<br>1.3442 | Feb<br>1.3403  | Mar<br>1.3365         | Apr<br>1.3187    | May<br>1.3154 | Jun<br>1.2999     | Jul<br>1.2999 | Aug<br>1.2970 | Sep<br>1.3059 | Oct<br>1.3154 | Nov<br>1.3221 | Dec<br>1.3292 (40) |
| HLP (average)                                                       |               |                |                       |                  |               |                   |               |               |               |               |               | 1.3187 (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                            |                      |          |          |          |          |          |         |          |          |          |                    | 2.7238 (42)    |
| Average daily hot water use (litres/day)     |                      |          |          |          |          |          |         |          |          |          |                    | 98.8906 (43)   |
|                                              | Jan                  | Feb      | Mar      | Apr      | May      | Jun      | Jul     | Aug      | Sep      | Oct      | Nov                | Dec            |
| Daily hot water use                          | 108.7797             | 104.8241 | 100.8685 | 96.9128  | 92.9572  | 89.0016  | 89.0016 | 92.9572  | 96.9128  | 100.8685 | 104.8241           | 108.7797 (44)  |
| Energy conte                                 | 161.3172             | 141.0890 | 145.5912 | 126.9300 | 121.7923 | 105.0975 | 97.3883 | 111.7545 | 113.0892 | 131.7946 | 143.8641           | 156.2271 (45)  |
| Energy content (annual)                      |                      |          |          |          |          |          |         |          |          |          | Total = Sum(45)m = | 1555.9348 (45) |
| Distribution loss                            | (46)m = 0.15 x (45)m |          |          |          |          |          |         |          |          |          |                    |                |
|                                              | 24.1976              | 21.1634  | 21.8387  | 19.0395  | 18.2688  | 15.7646  | 14.6082 | 16.7632  | 16.9634  | 19.7692  | 21.5796            | 23.4341 (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 ENERGY RATINGS FOR IMPROVED DWELLING 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 | 14.1437  | 12.7639  | 14.1060  | 13.6080  | 14.0283   | 13.5373   | 13.9646   | 14.0059   | 13.5758  | 14.0729  | 13.6581  | 14.1315 (61)    |
| Aperture area of solar collector                                | 175.4609 | 153.8529 | 159.6972 | 140.5380 | 135.8206  | 118.6348  | 111.3529  | 125.7604  | 126.6650 | 145.8674 | 157.5221 | 170.3586 (62)   |
| Zero-loss collector efficiency                                  |          |          |          |          |           |           |           |           |          |          |          | 3.0000 (H1)     |
| Collector heat loss coefficient                                 |          |          |          |          |           |           |           |           |          |          |          | 0.7000 (H2)     |
| Collector 2nd order heat loss coefficient                       |          |          |          |          |           |           |           |           |          |          |          | 1.8000 (H3)     |
| Collector effective heat loss coefficient                       |          |          |          |          |           |           |           |           |          |          |          | 0.0050 (H3a)    |
| Collector performance ratio                                     |          |          |          |          |           |           |           |           |          |          |          | 1.8063 (H3b)    |
| Annual solar radiation per m2                                   |          |          |          |          |           |           |           |           |          |          |          | 2.5804 (H4)     |
| Overshading factor                                              |          |          |          |          |           |           |           |           |          |          |          | 1079.5246 (H5)  |
| Solar energy available                                          |          |          |          |          |           |           |           |           |          |          |          | 0.8000 (H6)     |
| Adjustment factor for showers                                   |          |          |          |          |           |           |           |           |          |          |          | 1813.6014 (H7)  |
| Solar-to-load ratio                                             |          |          |          |          |           |           |           |           |          |          |          | 1.0000 (H7a)    |
| Utilisation factor                                              |          |          |          |          |           |           |           |           |          |          |          | 1.1656 (H8)     |
| Collector performance factor                                    |          |          |          |          |           |           |           |           |          |          |          | 0.5760 (H9)     |
| Dedicated solar storage volume                                  |          |          |          |          |           |           |           |           |          |          |          | 0.8793 (H10)    |
| Effective solar volume                                          |          |          |          |          |           |           |           |           |          |          |          | 75.0000 (H11)   |
| Daily hot water demand                                          |          |          |          |          |           |           |           |           |          |          |          | 75.0000 (H13)   |
| Volume ratio Veff/V                                             |          |          |          |          |           |           |           |           |          |          |          | 98.8906 (H14)   |
| Solar storage volume factor                                     |          |          |          |          |           |           |           |           |          |          |          | 0.7584 (H15)    |
| Solar input                                                     |          |          |          |          |           |           |           |           |          |          |          | 0.9447 (H16)    |
| Solar input                                                     |          |          |          |          |           |           |           |           |          |          |          | -867.6785 (H17) |
| Solar input                                                     | -25.1609 | -41.9864 | -71.5076 | -95.8343 | -118.3952 | -116.4014 | -114.8631 | -100.3564 | -78.5992 | -53.6740 | -29.8445 | -21.0554 (63)   |
| Solar input (sum of months) = Sum(63)m =                        |          |          |          |          |           |           |           |           |          |          |          | -867.6785 (63)  |
| Output from w/h                                                 |          |          |          |          |           |           |           |           |          |          |          |                 |
|                                                                 | 150.2999 | 111.8665 | 88.1896  | 44.7037  | 17.4254   | 2.2334    | 0.0000    | 25.4039   | 48.0658  | 92.1934  | 127.6776 | 149.3031 (64)   |
| Total per year (kWh/year) = Sum(64)m =                          |          |          |          |          |           |           |           |           |          |          |          | 857.3625 (64)   |
| Heat gains from water heating, kWh/month                        |          |          |          |          |           |           |           |           |          |          |          |                 |
|                                                                 | 57.1739  | 50.1031  | 51.9356  | 45.6062  | 44.0030   | 38.3292   | 35.8728   | 40.6598   | 40.9961  | 47.3399  | 51.2493  | 55.4784 (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                                                                               | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 56.5325   | 50.2116   | 40.8348   | 30.9146   | 23.1090   | 19.5096   | 21.0808   | 27.4017   | 36.7784   | 46.6987   | 54.5043   | 58.1037 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 378.5804  | 382.5089  | 372.6093  | 351.5341  | 324.9305  | 299.9268  | 283.2229  | 279.2944  | 289.1940  | 310.2692  | 336.8728  | 361.8764 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667 (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)                                 |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 (71) |
| Water heating gains (Table 5)                                                       |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 76.8466   | 74.5581   | 69.8059   | 63.3420   | 59.1438   | 53.2351   | 48.2161   | 54.6503   | 56.9390   | 63.6289   | 71.1796   | 74.5677 (72)   |
| Total internal gains                                                                |           |           |           |           |           |           |           |           |           |           |           |                |
|                                                                                     | 623.5025  | 618.8217  | 594.7930  | 557.3337  | 518.7264  | 484.2145  | 464.0628  | 472.8894  | 494.4546  | 532.1398  | 574.0997  | 606.0909 (73)  |

#### 6. Solar gains

| [Jan]       |          |           |           | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d | Gains<br>W    |          |          |               |
|-------------|----------|-----------|-----------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|---------------|----------|----------|---------------|
| North       |          |           |           | 13.3500    | 10.6334                        | 0.7200                            | 0.7000                             | 0.7700                       | 49.5812 (74)  |          |          |               |
| East        |          |           |           | 1.8900     | 19.6403                        | 0.7200                            | 0.7000                             | 0.7700                       | 12.9650 (76)  |          |          |               |
| South       |          |           |           | 9.9500     | 46.7521                        | 0.7200                            | 0.7000                             | 0.7700                       | 162.4754 (78) |          |          |               |
|             |          |           |           |            |                                |                                   |                                    |                              |               |          |          |               |
| Solar gains | 225.0216 | 386.2073  | 541.7303  | 702.6278   | 822.2447                       | 833.5592                          | 796.3274                           | 703.2859                     | 596.2394      | 429.8907 | 269.9194 | 192.3888 (83) |
| Total gains | 848.5241 | 1005.0291 | 1136.5233 | 1259.9615  | 1340.9711                      | 1317.7737                         | 1260.3902                          | 1176.1753                    | 1090.6939     | 962.0305 | 844.0191 | 798.4797 (84) |

#### 7. Mean internal temperature (heating season)

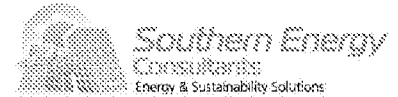
|                                                                             |         |         |         |         |         |         |         |         |                           |         |         |              |
|-----------------------------------------------------------------------------|---------|---------|---------|---------|---------|---------|---------|---------|---------------------------|---------|---------|--------------|
| 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                                                                         | 51.6631 | 51.8121 | 51.9590 | 52.6601 | 52.7934 | 53.4228 | 53.4228 | 53.5410 | 53.1786                   | 52.7934 | 52.5244 | 52.2462      |
| alpha                                                                       | 4.4442  | 4.4541  | 4.4639  | 4.5107  | 4.5196  | 4.5615  | 4.5615  | 4.5694  | 4.5452                    | 4.5196  | 4.5016  | 4.4831       |
| util living area                                                            | 0.9912  | 0.9808  | 0.9573  | 0.8957  | 0.7719  | 0.5922  | 0.4400  | 0.4883  | 0.7258                    | 0.9258  | 0.9824  | 0.9932 (86)  |
| MIT                                                                         | 19.7394 | 19.9510 | 20.2445 | 20.5915 | 20.8441 | 20.9647 | 20.9926 | 20.9884 | 20.9122                   | 20.5783 | 20.0942 | 19.7024 (87) |
| Th 2                                                                        | 19.8064 | 19.8094 | 19.8123 | 19.8262 | 19.8288 | 19.8409 | 19.8409 | 19.8432 | 19.8362                   | 19.8288 | 19.8235 | 19.8180 (88) |
| util rest of house                                                          | 0.9883  | 0.9747  | 0.9436  | 0.8631  | 0.7079  | 0.4968  | 0.3274  | 0.3709  | 0.6339                    | 0.8949  | 0.9757  | 0.9909 (89)  |
| MIT 2                                                                       | 18.1699 | 18.4768 | 18.8959 | 19.3789 | 19.6897 | 19.8199 | 19.8385 | 19.8390 | 19.7746                   | 19.3766 | 18.6966 | 18.1243 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.1922 (91)  |
| MIT                                                                         | 18.4715 | 18.7600 | 19.1550 | 19.6119 | 19.9115 | 20.0399 | 20.0603 | 20.0598 | 19.9932                   | 19.6075 | 18.9652 | 18.4275 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500      |
| adjusted MIT                                                                | 18.3215 | 18.6100 | 19.0050 | 19.4619 | 19.7615 | 19.8899 | 19.9103 | 19.9098 | 19.8432                   | 19.4575 | 18.8152 | 18.2775 (93) |

#### 8. Space heating requirement

|              |          |          |           |           |          |          |          |          |          |          |          |               |
|--------------|----------|----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Utilisation  | 0.9829   | 0.9661   | 0.9315    | 0.8510    | 0.7038   | 0.5010   | 0.3343   | 0.3778   | 0.6346   | 0.8825   | 0.9675   | 0.9865 (94)   |
| Useful gains | 834.0460 | 970.9669 | 1058.6315 | 1072.2739 | 943.7863 | 660.2528 | 421.3073 | 444.3942 | 692.1047 | 848.9613 | 816.5875 | 787.6696 (95) |

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

|                      |           |           |           |           |           |          |          |          |          |           |              |                |
|----------------------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|-----------|--------------|----------------|
| 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     | 1853.8291 | 1807.4391 | 1643.9157 | 1369.9830 | 1043.0209 | 676.3567 | 423.2488 | 447.7708 | 737.6834 | 1146.0088 | 1523.5001    | 1840.4674 (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    | 758.7186  | 562.1093  | 435.4514  | 214.3506  | 73.8305   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 221.0033  | 508.9771     | 783.2815 (98)  |
| Space heating        |           |           |           |           |           |          |          |          |          |           |              | 3557.7225 (98) |
| Space heating per m2 |           |           |           |           |           |          |          |          |          |           | (98) / (4) = | 36.1704 (99)   |

8c. Space cooling requirement

Not applicable

#### 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                                             |          |          |          |          |         |         |         |         |           |          |          | 3931.1851 (211) |
| Jan                                                                   | Feb      | Mar      | Apr      | May      | Jun     | Jul     | Aug     | Sep     | Oct       | Nov      | Dec      |                 |
| Space heating requirement                                             | 758.7186 | 562.1093 | 435.4514 | 214.3506 | 73.8305 | 0.0000  | 0.0000  | 0.0000  | 0.0000    | 221.0033 | 508.9771 | 783.2815 (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)                              | 838.3631 | 621.1153 | 481.1618 | 236.8515 | 81.5807 | 0.0000  | 0.0000  | 0.0000  | 0.0000    | 244.2026 | 562.4057 | 865.5045 (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                                             | 150.2999 | 111.8665 | 88.1896  | 44.7037  | 17.4254 | 2.2334  | 0.0000  | 25.4039 | 48.0658   | 92.1934  | 127.6776 | 149.3031 (64)   |
| Efficiency of water heater                                            | 89.9548  | 89.9527  | 89.9447  | 89.9311  | 89.8710 | 87.3000 | 87.3000 | 87.3000 | 87.3000   | 89.5339  | 89.8396  | 87.3000 (216)   |
| (217)m                                                                | 89.9548  | 89.9527  | 89.9447  | 89.9311  | 89.8710 | 87.3000 | 87.3000 | 87.3000 | 87.3000   | 89.5339  | 89.8396  | 89.9720 (217)   |
| Fuel for water heating, kWh/month                                     | 167.0838 | 124.3615 | 98.0486  | 49.7088  | 19.3893 | 2.5584  | 0.0000  | 29.0996 | 55.0582   | 102.9703 | 142.1173 | 165.9440 (219)  |
| Water heating fuel used                                               |          |          |          |          |         |         |         |         |           |          |          | 956.3398 (219)  |
| Annual totals kWh/year                                                |          |          |          |          |         |         |         |         |           |          |          |                 |
| Space heating fuel - main system                                      |          |          |          |          |         |         |         |         |           |          |          | 3931.1851 (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)  |
| pump for solar water heating                                          |          |          |          |          |         |         |         |         |           |          |          | 50.0000 (230g)  |
| Total electricity for the above, kWh/year                             |          |          |          |          |         |         |         |         |           |          |          | 125.0000 (231)  |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |         |         |         |         |           |          |          | 399.3523 (232)  |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |         |         |         |         |           |          |          |                 |
| PV Unit 0 (0.80 * 0.75 * 1080 * 0.80) =                               |          |          |          |          |         |         |         |         | -518.1718 |          |          | -518.1718 (233) |
| Total delivered energy for all uses                                   |          |          |          |          |         |         |         |         |           |          |          | 4893.7054 (238) |

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

|                                       |               |                  |                  |
|---------------------------------------|---------------|------------------|------------------|
|                                       | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |
| Space heating - main system 1         | 3931.1851     | 3.4800           | 136.8052 (240)   |
| Space heating - secondary             | 0.0000        | 0.0000           | 0.0000 (242)     |
| Water heating (other fuel)            | 956.3398      | 3.4800           | 33.2806 (247)    |
| Pumps and fans for heating            | 75.0000       | 13.1900          | 9.8925 (249)     |
| Pump for solar water heating          | 50.0000       | 13.1900          | 6.5950 (249)     |
| Energy for lighting                   | 399.3523      | 13.1900          | 52.6746 (250)    |
| Additional standing charges           |               |                  | 120.0000 (251)   |
| Energy saving/generation technologies |               |                  |                  |
| PV Unit                               | -518.1718     | 13.1900          | -68.3469 (252)   |
| Total energy cost                     |               |                  | 290.9011 (255)   |

#### 11a. SAP rating - Individual heating systems

|                                  |                                  |              |
|----------------------------------|----------------------------------|--------------|
| Energy cost deflator (Table 12): |                                  | 0.4200 (256) |
| Energy cost factor (ECF)         | [(255) x (256)] / [(4) + 45.0] = | 0.8522 (257) |
| SAP value                        |                                  | 88.1111      |
| SAP rating (Section 12)          |                                  | 88 (258)     |
| SAP band                         |                                  | B            |

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

|                               |                 |                            |                       |
|-------------------------------|-----------------|----------------------------|-----------------------|
|                               | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |
| Space heating - main system 1 | 3931.1851       | 0.2160                     | 849.1360 (261)        |
| Space heating - secondary     | 0.0000          | 0.0000                     | 0.0000 (263)          |
| Water heating (other fuel)    | 956.3398        | 0.2160                     | 206.5694 (264)        |
| Space and water heating       |                 |                            | 1055.7054 (265)       |
| Pumps and fans                | 125.0000        | 0.5190                     | 64.8750 (267)         |

Regs Region: England

Elmhurst Energy Systems

SAP2012 Calculator (Design

System) version 4.14r19

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



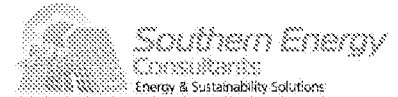
### CALCULATION OF ENERGY RATINGS FOR IMPROVED DWELLING 09 Jan 2014

|                                       |           |        |                 |
|---------------------------------------|-----------|--------|-----------------|
| Energy for lighting                   | 399.3523  | 0.5190 | 207.2639 (268)  |
| Energy saving/generation technologies |           |        |                 |
| PV Unit                               | -518.1718 | 0.5190 | -268.9312 (269) |
| Total kg/year                         |           |        | 1058.9131 (272) |
| CO2 emissions per m2                  |           |        | 10.7700 (273)   |
| EI value                              |           |        | 90.1022         |
| EI rating                             |           |        | 90 (274)        |
| EI band                               |           |        | B               |

-----

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

SAP 2012 WORKSHEET FOR New Build (As Designed) (Version 9.92, January 2014)  
 CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 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                                           | 51.9700 (1b)              | x 2.3500 (2b)                   | = 122.1295 (1b) - (3b)      |
| First floor                                            | 46.3900 (1c)              | x 2.6500 (2c)                   | = 122.9335 (1c) - (3c)      |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 98.3600                   |                                 | (4)                         |
| Dwelling volume                                        |                           | (3a)+(3b)+(3c)+(3d)+(3e)...(3n) | = 245.0630 (5)              |

#### 2. Ventilation rate

|                                                                           | main<br>heating | secondary<br>heating | other | total                       | m3 per hour                |
|---------------------------------------------------------------------------|-----------------|----------------------|-------|-----------------------------|----------------------------|
| Number of chimneys                                                        | 0               | +                    | 0     | =                           | 0 * 40 = 0.0000 (6a)       |
| Number of open flues                                                      | 0               | +                    | 0     | =                           | 0 * 20 = 0.0000 (6b)       |
| Number of intermittent fans                                               |                 |                      |       |                             | 5 * 10 = 50.0000 (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) = |                 |                      |       |                             | 50.0000 / (5) = 0.2040 (8) |
| Pressure test                                                             |                 |                      |       |                             | Yes                        |
| Measured/design AP50                                                      |                 |                      |       |                             | 5.0000                     |
| Infiltration rate                                                         |                 |                      |       |                             | 0.4540 (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) =        | 0.3859 (21)                |

|                 | Jan    | Feb    | Mar    | Apr    | May    | Jun    | Jul    | Aug    | Sep    | Oct    | Nov    | Dec          |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------------|
| Wind speed      | 5.6000 | 5.1000 | 4.8000 | 4.5000 | 4.7000 | 4.2000 | 4.4000 | 4.2000 | 4.4000 | 4.8000 | 4.9000 | 5.1000 (22)  |
| Wind factor     | 1.4000 | 1.2750 | 1.2000 | 1.1250 | 1.1750 | 1.0500 | 1.1000 | 1.0500 | 1.1000 | 1.2000 | 1.2250 | 1.2750 (22a) |
| Adj infilt rate |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac    | 0.5403 | 0.4921 | 0.4631 | 0.4342 | 0.4535 | 0.4052 | 0.4245 | 0.4052 | 0.4245 | 0.4631 | 0.4728 | 0.4921 (22b) |
|                 | 0.6460 | 0.6211 | 0.6072 | 0.5942 | 0.6028 | 0.5821 | 0.5901 | 0.5821 | 0.5901 | 0.6072 | 0.6118 | 0.6211 (25)  |

#### 3. Heat losses and heat loss parameter

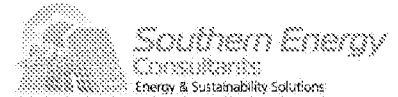
| Element                                                             | Gross<br>m2   | Openings<br>m2 | NetArea<br>m2        | U-value<br>W/m2K | A x U<br>W/K  | K-value<br>kJ/m2K | A x K<br>kJ/K |               |               |               |               |                    |
|---------------------------------------------------------------------|---------------|----------------|----------------------|------------------|---------------|-------------------|---------------|---------------|---------------|---------------|---------------|--------------------|
| Opening Type 1                                                      |               |                | 1.9500               | 1.5000           | 2.9250        |                   | (26)          |               |               |               |               |                    |
| Opening Type 2 (Uw = 1.30)                                          |               |                | 25.1900              | 1.2357           | 31.1283       |                   | (27)          |               |               |               |               |                    |
| Heat Loss Floor 1                                                   |               |                | 51.9700              | 0.1500           | 7.7955        |                   | (28a)         |               |               |               |               |                    |
| External Wall 1                                                     | 144.8800      | 27.1400        | 117.7400             | 0.2400           | 28.2576       |                   | (29a)         |               |               |               |               |                    |
| External Roof 1                                                     | 51.9700       |                | 51.9700              | 0.1100           | 5.7167        |                   | (30)          |               |               |               |               |                    |
| Total net area of external elements Aum(A, m2)                      |               |                | 248.8200             |                  |               |                   | (31)          |               |               |               |               |                    |
| Fabric heat loss, W/K = Sum (A x U)                                 |               |                | (26)...(30) + (32) = |                  | 75.8231       |                   | (33)          |               |               |               |               |                    |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m2K                   |               |                |                      |                  |               |                   | 250.0000 (35) |               |               |               |               |                    |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K)          |               |                |                      |                  |               |                   | 6.1647 (36)   |               |               |               |               |                    |
| Total fabric heat loss                                              |               |                |                      |                  |               | (33) + (36) =     | 81.9878 (37)  |               |               |               |               |                    |
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5) |               |                |                      |                  |               |                   |               |               |               |               |               |                    |
| (38)m                                                               | 52.2392       | 50.2255        | 49.1076              | 48.0575          | 48.7500       | 47.0751           | 47.7225       | 47.0751       | 47.7225       | 49.1076       | 49.4727       | 50.2255 (38)       |
| Heat transfer coeff                                                 | 134.2271      | 132.2133       | 131.0954             | 130.0453         | 130.7378      | 129.0629          | 129.7103      | 129.0629      | 129.7103      | 131.0954      | 131.4605      | 132.2133 (39)      |
| Average = Sum(39)m / 12 =                                           |               |                |                      |                  |               |                   |               |               |               |               |               | 130.8862 (39)      |
| HLP                                                                 | Jan<br>1.3647 | Feb<br>1.3442  | Mar<br>1.3328        | Apr<br>1.3221    | May<br>1.3292 | Jun<br>1.3121     | Jul<br>1.3187 | Aug<br>1.3121 | Sep<br>1.3187 | Oct<br>1.3328 | Nov<br>1.3365 | Dec<br>1.3442 (40) |
| HLP (average)                                                       |               |                |                      |                  |               |                   |               |               |               |               |               | 1.3307 (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                            |          |          |          |          |          |          |         |          |          |                    |          | 2.7238 (42)    |
| Average daily hot water use (litres/day)     |          |          |          |          |          |          |         |          |          |                    |          | 98.8906 (43)   |
| Daily hot water use                          | 108.7797 | 104.8241 | 100.8685 | 96.9128  | 92.9572  | 89.0016  | 89.0016 | 92.9572  | 96.9128  | 100.8685           | 104.8241 | 108.7797 (44)  |
| Energy conte                                 | 161.3172 | 141.0890 | 145.5912 | 126.9300 | 121.7923 | 105.0975 | 97.3883 | 111.7545 | 113.0892 | 131.7946           | 143.8641 | 156.2271 (45)  |
| Energy content (annual)                      |          |          |          |          |          |          |         |          |          | Total = Sum(45)m = |          | 1555.9348 (45) |
| Distribution loss (46)m = 0.15 x (45)m       | 24.1976  | 21.1634  | 21.8387  | 19.0395  | 18.2688  | 15.7646  | 14.6082 | 16.7632  | 16.9634  | 19.7692            | 21.5796  | 23.4341 (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 EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 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 | 14.1437  | 12.7639  | 14.1060  | 13.6080   | 14.0283   | 13.5373   | 13.9646   | 14.0059   | 13.5758  | 14.0729  | 13.6581  | 14.1315 (61)    |
| Aperture area of solar collector                                | 175.4609 | 153.8529 | 159.6972 | 140.5380  | 135.8206  | 118.6348  | 111.3529  | 125.7604  | 126.6650 | 145.8674 | 157.5221 | 170.3586 (62)   |
| Zero-loss collector efficiency                                  |          |          |          |           |           |           |           |           |          |          |          | 3.0000 (H1)     |
| Collector heat loss coefficient                                 |          |          |          |           |           |           |           |           |          |          |          | 0.7000 (H2)     |
| Collector 2nd order heat loss coefficient                       |          |          |          |           |           |           |           |           |          |          |          | 1.8000 (H3)     |
| Collector effective heat loss coefficient                       |          |          |          |           |           |           |           |           |          |          |          | 0.0050 (H3a)    |
| Collector performance ratio                                     |          |          |          |           |           |           |           |           |          |          |          | 1.8063 (H3b)    |
| Annual solar radiation per m2                                   |          |          |          |           |           |           |           |           |          |          |          | 2.5804 (H4)     |
| Overshading factor                                              |          |          |          |           |           |           |           |           |          |          |          | 1306.9326 (H5)  |
| Solar energy available                                          |          |          |          |           |           |           |           |           |          |          |          | 0.8000 (H6)     |
| Adjustment factor for showers                                   |          |          |          |           |           |           |           |           |          |          |          | 2195.6468 (H7)  |
| Solar-to-load ratio                                             |          |          |          |           |           |           |           |           |          |          |          | 1.0000 (H7a)    |
| Utilisation factor                                              |          |          |          |           |           |           |           |           |          |          |          | 1.4111 (H8)     |
| Collector performance factor                                    |          |          |          |           |           |           |           |           |          |          |          | 0.5077 (H9)     |
| Dedicated solar storage volume                                  |          |          |          |           |           |           |           |           |          |          |          | 0.8793 (H10)    |
| Effective solar volume                                          |          |          |          |           |           |           |           |           |          |          |          | 75.0000 (H11)   |
| Daily hot water demand                                          |          |          |          |           |           |           |           |           |          |          |          | 75.0000 (H13)   |
| Volume ratio Veff/V                                             |          |          |          |           |           |           |           |           |          |          |          | 98.8906 (H14)   |
| Solar storage volume factor                                     |          |          |          |           |           |           |           |           |          |          |          | 0.7584 (H15)    |
| Solar input                                                     |          |          |          |           |           |           |           |           |          |          |          | 0.9447 (H16)    |
| Solar input                                                     |          |          |          |           |           |           |           |           |          |          |          | -925.9464 (H17) |
| Solar input                                                     | -30.2962 | -42.2360 | -71.9087 | -100.1851 | -119.7922 | -126.5502 | -124.0629 | -108.8113 | -84.9489 | -58.1072 | -34.4607 | -24.5869 (63)   |
| Solar input (sum of months) = Sum(63)m =                        |          |          |          |           |           |           |           |           |          |          |          | -925.9464 (63)  |
| Output from w/h                                                 |          |          |          |           |           |           |           |           |          |          |          |                 |
|                                                                 | 145.1646 | 111.6169 | 87.7885  | 40.3529   | 16.0284   | 0.0000    | 0.0000    | 16.9491   | 41.7161  | 87.7602  | 123.0614 | 145.7717 (64)   |
| Total per year (kWh/year) = Sum(64)m =                          |          |          |          |           |           |           |           |           |          |          |          | 816.2099 (64)   |
| Heat gains from water heating, kWh/month                        |          |          |          |           |           |           |           |           |          |          |          |                 |
|                                                                 | 57.1739  | 50.1031  | 51.9356  | 45.6062   | 44.0030   | 38.3292   | 35.8728   | 40.6598   | 40.9961  | 47.3399  | 51.2493  | 55.4784 (65)    |

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

|                                                                                     |           |           |           |           |           |           |           |           |           |           |           |                |
|-------------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|----------------|
| Metabolic gains (Table 5), Watts                                                    |           |           |           |           |           |           |           |           |           |           |           |                |
| (66)m                                                                               | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290  | 163.4290 (66)  |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 56.5325   | 50.2116   | 40.8348   | 30.9146   | 23.1090   | 19.5096   | 21.0808   | 27.4017   | 36.7784   | 46.6987   | 54.5043   | 58.1037 (67)   |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 378.5804  | 382.5089  | 372.6093  | 351.5341  | 324.9305  | 299.9268  | 283.2229  | 279.2944  | 289.1940  | 310.2692  | 336.8728  | 361.8764 (68)  |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667   | 54.0667 (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)                                 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 | -108.9527 (71) |
| Water heating gains (Table 5)                                                       | 76.8466   | 74.5581   | 69.8059   | 63.3420   | 59.1438   | 53.2351   | 48.2161   | 54.6503   | 56.9390   | 63.6289   | 71.1796   | 74.5677 (72)   |
| Total internal gains                                                                | 623.5025  | 618.8217  | 594.7930  | 557.3337  | 518.7264  | 484.2145  | 464.0628  | 472.8894  | 494.4546  | 532.1398  | 574.0997  | 606.0909 (73)  |

#### 6. Solar gains

| [Jan]       |          |           |           |           |           | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | g<br>Specific data<br>or Table 6b | FF<br>Specific data<br>or Table 6c | Access<br>factor<br>Table 6d |          | Gains<br>W    |
|-------------|----------|-----------|-----------|-----------|-----------|------------|--------------------------------|-----------------------------------|------------------------------------|------------------------------|----------|---------------|
| North       |          |           |           |           |           | 13.3500    | 14.6401                        | 0.7200                            | 0.7000                             | 0.7700                       |          | 68.2635 (74)  |
| East        |          |           |           |           |           | 1.8900     | 27.3735                        | 0.7200                            | 0.7000                             | 0.7700                       |          | 18.0699 (76)  |
| South       |          |           |           |           |           | 9.9500     | 61.3950                        | 0.7200                            | 0.7000                             | 0.7700                       |          | 213.3633 (78) |
|             |          |           |           |           |           |            |                                |                                   |                                    |                              |          |               |
| Solar gains | 299.6966 | 430.1429  | 606.4965  | 825.7524  | 942.0684  | 1028.8248  | 975.4420                       | 860.1272                          | 720.0665                           | 516.0421                     | 344.7554 | 248.5231 (83) |
| Total gains | 923.1992 | 1048.9646 | 1201.2895 | 1383.0861 | 1460.7948 | 1513.0394  | 1439.5048                      | 1333.0166                         | 1214.5211                          | 1048.1820                    | 918.8551 | 854.6140 (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                                                                         | 50.8881 | 51.6631 | 52.1037 | 52.5244 | 52.2462 | 52.9242 | 52.6601 | 52.9242 | 52.6601                   | 52.1037 | 51.9590 | 51.6631      |
| alpha                                                                       | 4.3925  | 4.4442  | 4.4736  | 4.5016  | 4.4831  | 4.5283  | 4.5107  | 4.5283  | 4.5107                    | 4.4736  | 4.4639  | 4.4442       |
| util living area                                                            | 0.9829  | 0.9713  | 0.9355  | 0.8387  | 0.6680  | 0.4531  | 0.3142  | 0.3183  | 0.5553                    | 0.8414  | 0.9605  | 0.9864 (86)  |
| MIT                                                                         | 19.9591 | 20.1107 | 20.4031 | 20.7255 | 20.9231 | 20.9894 | 20.9984 | 20.9985 | 20.9759                   | 20.7853 | 20.3583 | 19.9485 (87) |
| Th 2                                                                        | 19.7905 | 19.8064 | 19.8152 | 19.8235 | 19.8180 | 19.8313 | 19.8262 | 19.8313 | 19.8262                   | 19.8152 | 19.8123 | 19.8064 (88) |
| util rest of house                                                          | 0.9770  | 0.9619  | 0.9149  | 0.7932  | 0.5895  | 0.3586  | 0.2095  | 0.2062  | 0.4444                    | 0.7792  | 0.9444  | 0.9815 (89)  |
| MIT 2                                                                       | 18.4771 | 18.7036 | 19.1177 | 19.5436 | 19.7594 | 19.8266 | 19.8259 | 19.8311 | 19.8148                   | 19.6227 | 19.0636 | 18.4738 (90) |
| Living area fraction                                                        |         |         |         |         |         |         |         |         | fLA = Living area / (4) = |         |         | 0.1922 (91)  |
| MIT                                                                         | 18.7619 | 18.9740 | 19.3647 | 19.7707 | 19.9830 | 20.0501 | 20.0512 | 20.0554 | 20.0379                   | 19.8461 | 19.3124 | 18.7571 (92) |
| Temperature adjustment                                                      |         |         |         |         |         |         |         |         |                           |         |         | -0.1500      |
| adjusted MIT                                                                | 18.6119 | 18.8240 | 19.2147 | 19.6207 | 19.8330 | 19.9001 | 19.9012 | 19.9054 | 19.8879                   | 19.6961 | 19.1624 | 18.6071 (93) |

#### 8. Space heating requirement

|              |          |          |           |           |          |          |          |          |          |          |          |               |
|--------------|----------|----------|-----------|-----------|----------|----------|----------|----------|----------|----------|----------|---------------|
| Utilisation  | 0.9688   | 0.9513   | 0.9018    | 0.7842    | 0.5906   | 0.3643   | 0.2162   | 0.2134   | 0.4505   | 0.7718   | 0.9325   | 0.9743 (94)   |
| Useful gains | 894.3725 | 997.8792 | 1083.3556 | 1084.6126 | 862.7293 | 551.2179 | 311.2166 | 284.4303 | 547.1622 | 809.0137 | 856.8708 | 832.6465 (95) |

Regs Region: England

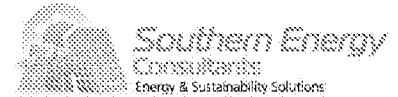
Elmhurst Energy Systems

SAP2012 Calculator (Design

System) version 4.14r19

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

|                      |           |           |           |           |          |          |          |          |          |              |           |                |
|----------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|--------------|-----------|----------------|
| Ext temp.            | 5.8000    | 6.0000    | 7.5000    | 9.8000    | 12.9000  | 15.6000  | 17.5000  | 17.7000  | 15.6000  | 12.5000      | 9.0000    | 6.0000 (96)    |
| Heat loss rate W     | 1719.6987 | 1695.5053 | 1535.7437 | 1277.1348 | 906.4115 | 554.9773 | 311.4614 | 284.6362 | 556.1821 | 943.3756     | 1335.9508 | 1666.8306 (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    | 614.0427  | 468.8047  | 336.5767  | 138.6159  | 32.4996  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 99.9652      | 344.9376  | 620.6330 (98)  |
| Space heating        |           |           |           |           |          |          |          |          |          |              |           | 2656.0754 (98) |
| Space heating per m2 |           |           |           |           |          |          |          |          |          | (98) / (4) = |           | 27.0036 (99)   |

8c. Space cooling requirement

Not applicable

#### 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                                             |          |          |          |          |         |         |         |         |           |          |          | 2934.8900 (211) |
| Jan                                                                   | Feb      | Mar      | Apr      | May      | Jun     | Jul     | Aug     | Sep     | Oct       | Nov      | Dec      |                 |
| Space heating requirement                                             | 614.0427 | 468.8047 | 336.5767 | 138.6159 | 32.4996 | 0.0000  | 0.0000  | 0.0000  | 0.0000    | 99.9652  | 344.9376 | 620.6330 (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)                              | 678.5002 | 518.0163 | 371.9080 | 153.1668 | 35.9111 | 0.0000  | 0.0000  | 0.0000  | 0.0000    | 110.4588 | 381.1465 | 685.7823 (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                                             | 145.1646 | 111.6169 | 87.7885  | 40.3529  | 16.0284 | 0.0000  | 0.0000  | 16.9491 | 41.7161   | 87.7602  | 123.0614 | 145.7717 (64)   |
| Efficiency of water heater                                            | 89.8701  | 89.8665  | 89.8189  | 89.7582  | 89.4174 | 87.3000 | 87.3000 | 87.3000 | 87.3000   | 88.9753  | 89.6360  | 87.3000 (216)   |
| Fuel for water heating, kWh/month                                     | 161.5271 | 124.2030 | 97.7394  | 44.9573  | 17.9254 | 0.0000  | 0.0000  | 19.4148 | 47.7848   | 98.6343  | 137.2901 | 162.1967 (219)  |
| Water heating fuel used                                               |          |          |          |          |         |         |         |         |           |          |          | 911.6729 (219)  |
| Annual totals kWh/year                                                |          |          |          |          |         |         |         |         |           |          |          |                 |
| Space heating fuel - main system                                      |          |          |          |          |         |         |         |         |           |          |          | 2934.8900 (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)  |
| pump for solar water heating                                          |          |          |          |          |         |         |         |         |           |          |          | 50.0000 (230g)  |
| Total electricity for the above, kWh/year                             |          |          |          |          |         |         |         |         |           |          |          | 125.0000 (231)  |
| Electricity for lighting (calculated in Appendix L)                   |          |          |          |          |         |         |         |         |           |          |          | 399.3523 (232)  |
| Energy saving/generation technologies (Appendices M ,N and Q)         |          |          |          |          |         |         |         |         |           |          |          |                 |
| PV Unit 0 (0.80 * 0.75 * 1307 * 0.80) =                               |          |          |          |          |         |         |         |         | -627.3276 |          |          | -627.3276 (233) |
| Total delivered energy for all uses                                   |          |          |          |          |         |         |         |         |           |          |          | 3743.5876 (238) |

#### 10a. Fuel costs - using BEDF prices (491)

|                                       |               |                  |                  |
|---------------------------------------|---------------|------------------|------------------|
|                                       | Fuel kWh/year | Fuel price p/kWh | Fuel cost £/year |
| Space heating - main system 1         | 2934.8900     | 3.6300           | 106.5365 (240)   |
| Space heating - secondary             | 0.0000        | 0.0000           | 0.0000 (242)     |
| Water heating (other fuel)            | 911.6729      | 3.6300           | 33.0937 (247)    |
| Pumps and fans for heating            | 75.0000       | 19.4400          | 14.5800 (249)    |
| Pump for solar water heating          | 50.0000       | 19.4400          | 9.7200 (249)     |
| Energy for lighting                   | 399.3523      | 19.4400          | 77.6341 (250)    |
| Additional standing charges           |               |                  | 95.0000 (251)    |
| Energy saving/generation technologies |               |                  |                  |
| PV Unit                               | -627.3276     | 19.4400          | -121.9525 (252)  |
| Total energy cost                     |               |                  | 214.6118 (255)   |

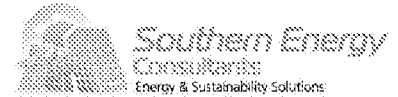
#### 12a. Carbon dioxide emissions - Individual heating systems including micro-CHP

|                                       |                 |                            |                       |
|---------------------------------------|-----------------|----------------------------|-----------------------|
|                                       | Energy kWh/year | Emission factor kg CO2/kWh | Emissions kg CO2/year |
| Space heating - main system 1         | 2934.8900       | 0.2160                     | 633.9362 (261)        |
| Space heating - secondary             | 0.0000          | 0.0000                     | 0.0000 (263)          |
| Water heating (other fuel)            | 911.6729        | 0.2160                     | 196.9213 (264)        |
| Space and water heating               |                 |                            | 830.8576 (265)        |
| Pumps and fans                        | 125.0000        | 0.5190                     | 64.8750 (267)         |
| Energy for lighting                   | 399.3523        | 0.5190                     | 207.2639 (268)        |
| Energy saving/generation technologies |                 |                            |                       |
| PV Unit                               | -627.3276       | 0.5190                     | -325.5831 (269)       |
| Total kg/year                         |                 |                            | 777.4134 (272)        |

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

# FULL SAP CALCULATION PRINTOUT

## Calculation Type: New Build (As Designed)



### CALCULATION OF EPC COSTS, EMISSIONS AND PRIMARY ENERGY FOR IMPROVED DWELLING 09 Jan 2014

|                                       | Energy<br>kWh/year | Primary energy factor<br>kg CO2/kWh | Primary energy<br>kWh/year |
|---------------------------------------|--------------------|-------------------------------------|----------------------------|
| Space heating - main system 1         | 2934.8900          | 1.2200                              | 3580.5658 (261)            |
| Space heating - secondary             | 0.0000             | 0.0000                              | 0.0000 (263)               |
| Water heating (other fuel)            | 911.6729           | 1.2200                              | 1112.2409 (264)            |
| Space and water heating               |                    |                                     | 4692.8067 (265)            |
| Pumps and fans                        | 125.0000           | 3.0700                              | 383.7500 (267)             |
| Energy for lighting                   | 399.3523           | 3.0700                              | 1226.0117 (268)            |
| Energy saving/generation technologies |                    |                                     |                            |
| PV Unit                               | -627.3276          | 3.0700                              | -1925.8959 (269)           |
| Primary energy kWh/year               |                    |                                     | 4376.6725 (272)            |
| Primary energy kWh/m2/year            |                    |                                     | 44.4965 (273)              |

SAP 2012 OVERHEATING ASSESSMENT FOR New Build (As Designed) 9.92

#### Overheating Calculation Input Data

|                                           |                           |
|-------------------------------------------|---------------------------|
| Dwelling type                             | Detached House            |
| Number of storeys                         | 2                         |
| Cross ventilation possible                | Yes                       |
| SAP Region                                | Thames Valley             |
| Front of dwelling faces                   | South                     |
| Overshading                               | Average or unknown        |
| Thermal mass parameter                    | 250.0                     |
| Night ventilation                         | Yes                       |
| Ventilation rate during hot weather (ach) | 8.00 (Windows fully open) |

#### Overheating Calculation

|                                          |             |
|------------------------------------------|-------------|
| Summer ventilation heat loss coefficient | 646.97 (P1) |
| Transmission heat loss coefficient       | 81.99 (37)  |
| Summer heat loss coefficient             | 728.95 (P2) |

| Overhangs   | Ratio | Z_overhangs | Overhang type |
|-------------|-------|-------------|---------------|
| Orientation |       |             |               |
| North       | 0.000 | 1.000       | None          |
| East        | 0.000 | 1.000       | None          |
| South       | 0.000 | 1.000       | None          |

| Solar shading | Z blinds | Solar access | Z overhangs | Z summer   |
|---------------|----------|--------------|-------------|------------|
| Orientation   |          |              |             |            |
| North         | 1.000    | 0.90         | 1.000       | 0.900 (P8) |
| East          | 1.000    | 0.90         | 1.000       | 0.900 (P8) |
| South         | 1.000    | 0.90         | 1.000       | 0.900 (P8) |

| [Jul]  | 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 | Shading | Gains<br>W |
|--------|------------|--------------------------------|-----------------------------------|------------------------------------|---------|------------|
| North  | 13.3500    | 81.1852                        | 0.7200                            | 0.7000                             | 0.9000  | 442.4595   |
| East   | 1.8900     | 117.5071                       | 0.7200                            | 0.7000                             | 0.9000  | 90.6654    |
| South  | 9.9500     | 112.2060                       | 0.7200                            | 0.7000                             | 0.9000  | 455.7794   |
| total: |            |                                |                                   |                                    |         | 988.9043   |

|                                                        |                 |                 |                 |      |
|--------------------------------------------------------|-----------------|-----------------|-----------------|------|
|                                                        | Jun             | Jul             | Aug             |      |
| Solar gains                                            | 1047            | 989             | 889             | (P3) |
| Internal gains                                         | 481             | 461             | 470             |      |
| Total summer gains                                     | 1529            | 1450            | 1359            | (P5) |
| Summer gain/loss ratio                                 | 2.10            | 1.99            | 1.86            | (P6) |
| Summer external temperature                            | 16.00           | 17.90           | 17.80           |      |
| Thermal mass temperature increment (TMP = 250.0)       | 0.25            | 0.25            | 0.25            |      |
| Threshold temperature                                  | 18.35           | 20.14           | 19.91           | (P7) |
| Likelihood of high internal temperature                | Not significant | Not significant | Not significant |      |
| Assessment of likelihood of high internal temperature: | Not significant |                 |                 |      |

## Southern Energy Consultants Ltd

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



**Southern Energy**  
Consultants  
Energy & Sustainability Solutions