

# Energy Statement

Plant Hill, Manchester

Project number: 9532

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## 1 Executive Summary

This report has been produced by Base Energy on behalf of Irwell Valley Development Ltd and in support of the planning application for the development named as Plant Hill, Manchester comprising of 12 semi-detached houses falling under the requirements of Manchester City Council.

It sets out the design approach with regards to energy and carbon dioxide emissions in order to ensure the development complies with:

- National Planning Policy
- The Manchester City Council Local Plan Policies EN4 and EN6

The above policies require:

- That the development follows the energy hierarchy
- An energy statement to show regulated energy demand and carbon dioxide emissions and the impact of the design proposals

The design of the development will incorporate energy efficient building fabric and services in addition to low carbon technology:

- Thermal specification exceeding Part L 2021 minimum standards
- A design which limits air permeability, targeting 4.00
- Energy saving building services including low energy lighting
- Low carbon Air Source Heat Pumps to provide space heating and solar PV

This results in a 75% reduction in CO<sub>2</sub> over Part L 2021 compliance and a 42% saving in energy demand

## 2 Existing and Proposed Development

The development site is located on land at Plant Hill Road, Manchester.

The development proposals are for 12, 3 storey semi-detached houses.

The development proposals constitute a major development.



**Figure 2.1: Site Location and proposals**

Aspects of the site location, shape, and surroundings (in particular the adjacent buildings), along with any other requirements of planning, use type, and scale will naturally constrain the development proposals in terms of the layout, positioning, and orientation of the proposed development. Subsequently, these constraints will impact on the feasibility of certain renewable technologies (as discussed in Section 4 of this report).

### 3 Planning Policy

#### National Planning Policy Framework 2021

The NPPF was updated in July 2021 to place greater emphasis on beauty, place-making, the environment, and sustainable development. The strengthened environmental objectives aim to protect and enhance the natural, built, and historic environment, and encourage effective land use, greater biodiversity, prudent use of natural resources, minimisation of waste and pollution, and adaptation to climate change alongside a move to a low carbon economy.

#### Local Planning Policy

The relevant Manchester City Council local planning policy requirements are as follows:

**Development Management Policy EN 4** of Manchester City Council's Core Strategy document sets requirements for 'Reducing CO<sub>2</sub> Emissions by Enabling Low and Zero Carbon Development'.

*"The Council will seek to reduce fuel poverty and decouple growth in the economy, growth in CO<sub>2</sub> emissions, and rising fossil fuel prices, through the following actions:*

- *All development must follow the principle of the Energy Hierarchy, being designed:*
  - *to reduce the need for energy through design features that provide passive heating, natural lighting and cooling*
  - *to reduce the need for energy through energy efficient features such as improved insulation and glazing*
  - *to meet residual energy requirements through the use of low or zero carbon energy generating technologies*
- *Wherever possible new development and retrofit projects, including energy generation plant, must be located and designed in a manner that allows advantage to be taken of opportunities for low and zero carbon energy supplies.*
- *Where possible new development and retrofit projects will be used as a mechanism to help improve energy efficiency and provide low and zero carbon energy supplies to existing buildings.*
- *Where appropriate new development and retrofit projects will be required to connect to and/or make contributions to low or zero carbon energy schemes and/or to incorporate provision to enable future connection to any existing / potential decentralised energy schemes.*
- *The use of building materials with low embodied carbon in new development and refurbishment schemes.*

An Energy Statement is required by the Local Authority in line with **Policy EN6** of the Manchester Core Strategy Development Plan which sets out carbon dioxide reduction targets and states the following:

*“Applications for residential development of 10 or more units and all other development over 1,000 sq m will be expected as a minimum to meet the target shown in Tables 12.1 or 12.2, unless this can be shown not to be viable. This should be demonstrated through an energy statement, submitted as part of the Design and Access Statement. Such a statement will be expected to set out the projected regulated energy demand and associated CO<sub>2</sub> emissions for all phases of the development.*

*The target framework relates to three broad development locations and their potential for low and zero carbon, decentralised energy. The areas are defined as follows.*

- *Target 1 Network development areas: Locations where the proximity of new and existing buildings, the mix of uses and density of development provide the right conditions to support district heating (and cooling).*
- *Target 2 Electricity intense areas: Locations where the predominant building type has an all electric fit-out such as retail units and leisure complexes.*
- *Target 3 Micro-generation areas: Locations where lower densities and a fragmented mix of uses tend to mean that only building scale solutions are practical.”*

#### Domestic CO<sub>2</sub> emissions reduction targets

**Table 12.1**

| Target                                         | % Minimum requirement                                                                         |
|------------------------------------------------|-----------------------------------------------------------------------------------------------|
| <b>Target 1: Network development area</b>      | CHP/district heating anchor or connection or where not feasible a 15% increase on Part L 2010 |
| <b>Target 2: Electricity intense buildings</b> | +15% increase on Part L 2010                                                                  |
| <b>Target 3: Micro generation area</b>         | +15% increase on Part L 2010                                                                  |

The development is more than the 10 units threshold and therefore triggers the above targets. Due to the building regulations being updated, the dwellings will follow the Part L 2021 guidelines which supersede the above targets. Part L 2021 is a 37% saving in CO<sub>2</sub> emissions over Part L 2010.

## 4 Methodology

The Standard Assessment Procedure (SAP) is the UK Government methodology for assessing and calculating the energy performance of dwellings.

The Simplified Building Energy Model (SBEM) is the UK Government methodology for assessing and calculating the energy performance of non-domestic buildings.

SAP and SBEM calculations take into account a range of factors that contribute to energy efficiency, including:

- Materials used for the construction and the thermal insulation of the building fabric (u-values<sup>1</sup> and thermal mass)
- Air permeability
- Efficiency, fuel source, and control of heating and cooling systems
- Ventilation system energy use and heat recovery
- Lighting energy
- Low carbon and energy saving or generating technologies

Approved Document Part L of current Building Regulations addresses the conservation of fuel and power. Part L is divided into two separate documents:

- Part L1 Newly constructed and extended or renovated existing dwellings
- Part L2 Newly constructed and extended or renovated existing non-domestic buildings

To comply with Part L, the calculations should demonstrate how the building will either meet or achieve a percentage reduction in the Building Emission Rate (BER) under the required Target Emission Rate (TER).

The calculation software has been used to calculate a baseline of energy demand and carbon dioxide emissions as appropriate from which any reductions or contributions have been measured.

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<sup>1</sup> U-values (Thermal Transmittance) - the measure of the overall rate of heat transfer by all mechanisms under standard conditions, through a particular section of a construction. Lower u-values mean better thermal insulation

## 5 Baseline Energy & CO2

Energy modelling software has been used to calculate a baseline for the development. This forms the basis from which compliance with planning policy has been measured.

**Table 5.1: Baseline CO2**

|                 | CO2 Emission Rate<br>(kg CO2/m2/year) | Floor Area<br>(m2) | Total Baseline Emissions<br>(kg CO2/year) |
|-----------------|---------------------------------------|--------------------|-------------------------------------------|
| <b>Baseline</b> | 11.14                                 | 99                 | 1,103                                     |

The **Total Baseline CO2 Emissions** for the development are shown to be 1066 kg/year.

## 6 Low Carbon Design – Fabric First – Be Lean

Before considering low carbon energy generating technology the development has been designed to reduce energy demand through the first step of the energy hierarchy by considering 'fabric first'. A thermally efficient building envelope will follow the design standards as set out below.

**Table 6.0: Building Fabric Standards (including u-values W/m<sup>2</sup>K)**

|                         | Part L 2013 Limiting Parameters | Part L 2021 Limiting Parameters | Part L 2021 Notional Targets | Proposed Development |
|-------------------------|---------------------------------|---------------------------------|------------------------------|----------------------|
| <b>Walls</b>            | 0.30                            | 0.26                            | 0.18                         | 0.18                 |
| <b>Ground Floor</b>     | 0.25                            | 0.18                            | 0.13                         | 0.10                 |
| <b>Roof ceiling</b>     | 0.20                            | 0.16                            | 0.11                         | 0.11                 |
| <b>Roof pitched</b>     | 0.20                            | 0.16                            | 0.11                         | 0.13                 |
| <b>Windows</b>          | 2.00                            | 1.6                             | 1.2                          | 1.2                  |
| <b>Doors</b>            | 2.00                            | 1.6                             | 1.0                          | 1.0                  |
| <b>Air permeability</b> | 10.00                           | 8.00                            | 5.00                         | 4.0                  |

- Insulation: The specified building envelope is designed to exceed the notional Part L targets and will help to limit the energy demand of the dwelling for space heating
- Thermal bridging: The design will seek to limit heat loss through thermal bridging targeting a global 'y-value' of 0.05

Once heat retention has been addressed the next step is to ensure energy consuming building services are efficient.

- Lighting: Low energy LED lighting throughout with a minimum efficacy of 80 lumens per watt
- Space & Water Heating: Air Source Heat Pump
- Heating Controls: Comprising time & temperature zone control
- Ventilation: Natural ventilation with continuous mechanical ventilation

## 7 Low Carbon Technology Review & Recommendations

Having set out an energy efficient design, the next step is to incorporate low carbon technology for energy generation. A number of technologies exist and should be specified where they:

- compliance with planning policy
- are feasible for the site
- are cost efficient
- are appropriate for proposed development form and function
- protect against fuel poverty
- promote fuel security
- reduce reliance on fossil fuels
- reduce carbon emissions
- reduce resource depletion
- reduce pollution

Site location and development form and function will influence the suitability of different technologies through:

- Orientation
- Space (inside and outside of the buildings)
- Surrounding topography, structures, and natural features
- Wind speed
- Overshading
- Geology and ground conditions
- Building form, function, and density

In determining the most feasible renewable technologies for the dwelling, the following have been reviewed:

- Wind turbines
- Ground Source Heat Pumps
- Air Source Heat Pumps
- Biomass
- Combined Heat and Power
- Photovoltaic Panels

- Solar water heating

### WIND TURBINES

Wind turbines are used to produce electricity. They can be either pole mounted (in a suitably exposed position) or building mounted; building mounted systems need a sufficient wind speed at the structural height and both a structural survey and planning permission.

- Wind speed can be too low on low rise buildings
- Taller systems need sufficient space
- Wind resources very variable and unpredictable
- May need planning permission

Wind turbines technology is **not recommended** for this development

### GROUND SOURCE HEAT PUMP (GSHP)

GSHPs use naturally occurring underground low-level heat in areas with appropriate geological features. Heat is transferred from the ground by either extracting and discharging (re-charging) water from/to the ground directly (open loop) or circulating water through pipes buried within the ground, (closed loop). The water is passed through a heat pump to transfer the heat from this water into a higher temperature water circuit to provide heating. The loop can be fitted horizontally (laid in a shallow trench) or vertically (in a borehole).

- Feasibility analysis is costly
- Suitable ground conditions required
- More capital intensive than air source heat pumps
- Can be more efficient and lower running costs than ASHPs
- Well suited to highly insulated buildings

Ground source heat pump technology is **not recommended** for this development

### AIR SOURCE HEAT PUMP (ASHP)

ASHP systems absorb heat from outside air at a low temperature into a fluid which is then passed through an electrically driven compressor where its temperature is increased. There are two main types of ASHP systems: Air to Water systems distribute heat through wet central heating; Air to air produce warm air which is circulated by fans. For an ASHP system to be installed, there needs to be ample outdoor space for the external condensing unit; these units can also be noisy and blow out colder air to the neighbouring environment.

- Requires space for external plant and internal hot water tank for wet systems supplying DHW
- Can generate noise though quieter systems have been developed
- Least efficient when most needed
- Longer life than fossil fuel boilers
- High capital costs vs gas systems but lower than GSHPs
- Well suited to highly insulated buildings

Air source heat pump technology **is recommended** for this development

## BIOMASS

Biomass systems burn wood pellets, chips, or logs to provide heat in a single room, or to power central heating and hot water boilers. There needs to be ample space available for both the boiler and the storage of fuel. There will also be regular deliveries of fuel and therefore adequate site access is required.

- Carbon emissions are cyclical unlike fossil fuel
- Requires fuel storage space and bulk delivery
- Carbon 'neutral' fuel in isolation but supply side emissions are still present so not neutral overall
- Harmful particulate emissions impact air quality and health

Biomass technology **is not recommended** for this development

## COMBINED HEAT AND POWER (CHP)

CHP is effectively an on-site small power plant providing both electrical power and thermal heat energy. It is an energy efficiency and low carbon measure rather than a renewable energy technology. A CHP system operates by burning a primary fuel (normally natural gas) by use of either a reciprocating engine or turbine, which in turn drives an alternator to generate electrical power. The heat emitted by the engine and exhaust gases is recovered and used to heat the building or to provide hot water.

- Reduces consumption of and reliance on grid electricity
- Works best with high and consistent heat and hot water demand
- Recovers waste energy
- Can export to the grid
- Uses fossil fuel
- Emissions on site rather than upstream
- Efficiency is sensitive to sizing

CHP **is not recommended** for this development

## DISTRICT HEATING

District Heating systems provide multiple buildings or dwellings with heat and hot water from a central boiler house, or 'energy centre'. The system can provide heating or cooling which is transferred from the energy centre through a network of highly insulated pipes carrying the heated water to each dwelling.

- Economies of scale
- Frees up space in habitable areas of development
- Variety of systems
- Can make use of waste heat from industry
- Can be fossil fuel based and dependent

There are no known existing or proposed heat networks or energy centres within a suitable radius from the development and there are no existing networks local to the site.

District heating **is not recommended** for this development

### SOLAR PHOTOVOLTAIC (PV)

Solar PV cells (which are mounted together in panels or tiles on the roof) convert sunlight into electricity. The cells are made from layers of semi-conducting material; when the light shines on the cell, an electric field is created across the layers. Although PV cells are most effective in bright sunlight, they can still generate electricity on a cloudy day. The power of a PV cell is measured in kilowatts peak (kWp). Each PV panel produces 0.25Watts to 0.35Watts depending on the manufacture.

- Passive technology, requires no energy input from grid
- Does not require sunny days to generate power
- Capital costs can be high although payback is effective
- Needs sufficient roof space and orientation
- Zero site or upstream emissions
- Can export to the grid

Solar PV technology **is recommended** for this development, however limited due to the roof layout. There is potentially space for 4-6 panels per plot.

### SOLAR HOT WATER

Solar hot water systems absorb energy from the sun and transfer this energy using heat exchangers to heat water which can then be stored. Systems should be roof mounted and oriented to face between a south-east and south-west direction.

- Mostly passive technology but requires pump energy
- Not suitable for combi boilers and developments without roof space
- Lower CO2 reductions than other technologies

Solar hot water technology **is not recommended** for this development

### Low Carbon Technology Summary

The low carbon technology review indicates that ASHP and solar PV would be potentially feasible. The following low carbon technology is recommended:

#### ASHP

This technology is deemed optimal for meeting the needs of the development and achieving policy compliance, there is also potential for a small amount of solar PV approx. 4-6 panels. The Heat Pump and 4 PV panels have been incorporated into the energy model and the results are presented in the next section.

## 8 Low Carbon Technology – Renewable Energy Generation – Part L 2021

The selected Low Carbon Technology has been incorporated into the calculation and the results are set out below.

**Table 8.1: Baseline vs Be Green CO2 using SAP 10**

|                        | CO2 Emission Rate<br>(kg CO2/m2/year) | Floor Area<br>(m2) | Total Baseline Emissions<br>(kg CO2/year) | Reduction in CO2 |
|------------------------|---------------------------------------|--------------------|-------------------------------------------|------------------|
| <b>Baseline</b>        | 10.77                                 | 99                 | 1066                                      | N/A              |
| <b>Be Green Design</b> | 2.75                                  | 99                 | 272.25                                    | <b>75.3%</b>     |

**Table 8.2: Baseline vs Be Green Energy Demand**

|                        | Energy Demand<br>(kWh/m2/year) | Floor Area<br>(m2) | Reduction in Energy Demand |
|------------------------|--------------------------------|--------------------|----------------------------|
| <b>Baseline</b>        | 58.25                          | 99                 | N/A                        |
| <b>Be Green Design</b> | 33.53                          | 99                 | <b>42.44%</b>              |

**Table 8.2: Baseline vs Fabric Energy Efficiency**

|                        | Energy Demand<br>(kWh/m2/year) | Floor Area<br>(m2) | Reduction in Energy Demand |
|------------------------|--------------------------------|--------------------|----------------------------|
| <b>Baseline</b>        | 35.98                          | 99                 | N/A                        |
| <b>Be Green Design</b> | 34.83                          | 99                 | <b>3.2%</b>                |

**Table 8.2: Baseline vs Be Green Energy Demand**

|                        | Total Energy Demand<br>(kWh/m2/year) | ASHP Energy Demand<br>(kWh/m2/year) | Reduction in Energy Demand |
|------------------------|--------------------------------------|-------------------------------------|----------------------------|
| <b>Be Green Design</b> | 3102                                 | 2806                                | <b>95%</b>                 |

Total energy demand is 3102 kWh/m2/year of which 2806 kWh/m2/year is via heat pump. Therefore this is a 95% saving in energy demand is provided by the ASHP. Solar PV 4 panels are added, this reduces the total energy demand to 1,720kWh/year.

## 9 Conclusion

Proposals are for the development named as Plant Hill, Manchester comprising of 12 semi-detached houses falling under the requirements of Manchester City Council. Under the local planning policy the proposed development is required to show a 15% saving in CO2 emissions over Part L 2010, however the project is required to meet Part L 2021 and this supersedes the planning requirements.

Energy modelling software has been used to calculate a baseline against which compliance with the above can be measured.

The proposed development will be designed to limit energy demand through the inclusion of a thermally efficient building fabric and energy efficient services.

Low carbon technology will be incorporated and is to comprise an ASHP and were feasible solar PV.

This results in a 75% saving in CO2 emissions over Part L 2021.

**This Energy Statement and the calculations on which it is based demonstrate that the proposed development complies with the local planning policy requirements.**

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## 10 Appendix 1 – SAP DER Worksheet Plot 12

# Full SAP Calculation Printout



|                                    |                                                    |                |                     |
|------------------------------------|----------------------------------------------------|----------------|---------------------|
| Property Reference                 | S9352 12                                           | Issued on Date | 30/11/2023          |
| Assessment Reference               | v2                                                 | Prop Type Ref  | Semi-detached house |
| Property                           | Plot 12, south east facing, Plant Hill, Manchester |                |                     |
| SAP Rating                         | 86 B                                               | DER            | 2.75                |
| Environmental                      | 98 A                                               | % DER < TER    | 75.31               |
| CO <sub>2</sub> Emissions (t/year) | 0.23                                               | DFEE           | 34.83               |
| Compliance Check                   | See BREL                                           | % DFEE < TFEE  | 3.19                |
| % DPER < TPER                      | 42.44                                              | DPER           | 33.53               |
| Assessor Details                   | Mr. Peter Kinsella                                 | Assessor ID    | L770-0002           |
| Client                             |                                                    |                |                     |

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

## 1. Overall dwelling characteristics

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)                        | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------------------|-----------------------------|
| Ground floor                                           | 35.0000 (1b)              | x 2.4000 (2b)                               | = 84.0000 (1b) - (3b)       |
| First floor                                            | 32.0000 (1c)              | x 2.6000 (2c)                               | = 83.2000 (1c) - (3c)       |
| Second floor                                           | 32.0000 (1d)              | x 2.5000 (2d)                               | = 80.0000 (1d) - (3d)       |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 99.0000                   |                                             | (4)                         |
| Dwelling volume                                        |                           | (3a) + (3b) + (3c) + (3d) + (3e) ... (3n) = | 247.2000 (5)                |

## 2. Ventilation rate

|                                                                                                    | m <sup>3</sup> per hour                 |
|----------------------------------------------------------------------------------------------------|-----------------------------------------|
| Number of open chimneys                                                                            | 0 * 80 = 0.0000 (6a)                    |
| Number of open flues                                                                               | 0 * 20 = 0.0000 (6b)                    |
| Number of chimneys / flues attached to closed fire                                                 | 0 * 10 = 0.0000 (6c)                    |
| Number of flues attached to solid fuel boiler                                                      | 0 * 20 = 0.0000 (6d)                    |
| Number of flues attached to other heater                                                           | 0 * 35 = 0.0000 (6e)                    |
| Number of blocked chimneys                                                                         | 0 * 20 = 0.0000 (6f)                    |
| Number of intermittent extract fans                                                                | 1 * 10 = 10.0000 (7a)                   |
| Number of passive vents                                                                            | 0 * 10 = 0.0000 (7b)                    |
| Number of flueless gas fires                                                                       | 0 * 40 = 0.0000 (7c)                    |
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 10.0000 / (5) = 0.0405 (8)              |
| Pressure test                                                                                      | Yes                                     |
| Pressure Test Method                                                                               | Blower Door                             |
| Measured/design AP50                                                                               | 4.0000 (17)                             |
| Infiltration rate                                                                                  | 0.2405 (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) = 0.2044 (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                                                                                         | 0.2606 | 0.2555 | 0.2504 | 0.2248 | 0.2197 | 0.1942 | 0.1942 | 0.1891 | 0.2044 | 0.2197 | 0.2299 | 0.2402 (22b) |
| Mechanical extract ventilation - decentralised                                                          |        |        |        |        |        |        |        |        |        |        |        | 0.5000 (23a) |
| If mechanical ventilation                                                                               |        |        |        |        |        |        |        |        |        |        |        | 0.5000 (23b) |
| If exhaust air heat pump using Appendix N, (23b) = (23a) x Fmv (equation (N5)), otherwise (23b) = (23a) |        |        |        |        |        |        |        |        |        |        |        |              |
| Effective ac                                                                                            | 0.5106 | 0.5055 | 0.5004 | 0.5000 | 0.5000 | 0.5000 | 0.5000 | 0.5000 | 0.5000 | 0.5000 | 0.5000 | 0.5000 (25)  |

## 3. Heat losses and heat loss parameter

| Element                                                         | Gross<br>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 |
|-----------------------------------------------------------------|-------------------------|----------------------------|---------------------------|-------------------------------|--------------|--------------------------------|---------------|
| Door                                                            |                         |                            | 1.8900                    | 1.0000                        | 1.8900       |                                | (26)          |
| Windows (Uw = 1.20)                                             |                         |                            | 21.2000                   | 1.1450                        | 24.2748      |                                | (27)          |
| Heat Loss Floor 1                                               |                         |                            | 35.0000                   | 0.1100                        | 3.8500       |                                | (28a)         |
| External Wall 1                                                 | 115.6000                | 23.0900                    | 92.5100                   | 0.1800                        | 16.6518      |                                | (29a)         |
| External Roof 1                                                 | 8.3000                  |                            | 8.3000                    | 0.1300                        | 1.0790       |                                | (30)          |
| Roof ceiling                                                    | 24.0000                 |                            | 24.0000                   | 0.1000                        | 2.4000       |                                | (30)          |
| Total net area of external elements Aum(A, m <sup>2</sup> )     |                         |                            | 182.9000                  |                               |              |                                | (31)          |
| Fabric heat loss, W/K = Sum (A x U)                             |                         |                            |                           | (26)...(30) + (32) =          | 50.1456      |                                | (33)          |
| Party Wall 1                                                    |                         |                            | 66.7000                   | 0.0000                        | 0.0000       |                                | (32)          |
| Thermal mass parameter (TMP = Cm / TFA) in kJ/m <sup>2</sup> K  |                         |                            |                           |                               |              |                                | 250.0000 (35) |
| Thermal bridges (User defined value 0.050 * total exposed area) |                         |                            |                           |                               |              |                                | 9.1450 (36)   |
| Point Thermal bridges                                           |                         |                            |                           |                               |              | (36a) =                        | 0.0000        |
| Total fabric heat loss                                          |                         |                            |                           |                               |              | (33) + (36) + (36a) =          | 59.2906 (37)  |

# Full SAP Calculation Printout



|                                                                                     |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
|-------------------------------------------------------------------------------------|-----------------|-----------------|--------------------------------|-----------------|-----------------------------------|-----------------|------------------------------------|-----------------|------------------------------|-----------------|-----------------|----------------------|
| Ventilation heat loss calculated monthly (38)m = 0.33 x (25)m x (5)                 |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| (38)m                                                                               | Jan<br>41.6520  | Feb<br>41.2352  | Mar<br>40.8183                 | Apr<br>40.7880  | May<br>40.7880                    | Jun<br>40.7880  | Jul<br>40.7880                     | Aug<br>40.7880  | Sep<br>40.7880               | Oct<br>40.7880  | Nov<br>40.7880  | Dec<br>40.7880 (38)  |
| Heat transfer coeff                                                                 | 100.9426        | 100.5258        | 100.1089                       | 100.0786        | 100.0786                          | 100.0786        | 100.0786                           | 100.0786        | 100.0786                     | 100.0786        | 100.0786        | 100.0786 (39)        |
| Average = Sum(39)m / 12 =                                                           |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 100.1904             |
| HLP                                                                                 | Jan<br>1.0196   | Feb<br>1.0154   | Mar<br>1.0112                  | Apr<br>1.0109   | May<br>1.0109                     | Jun<br>1.0109   | Jul<br>1.0109                      | Aug<br>1.0109   | Sep<br>1.0109                | Oct<br>1.0109   | Nov<br>1.0109   | Dec<br>1.0109 (40)   |
| HLP (average)                                                                       |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 1.0120               |
| Days in mont                                                                        | 31              | 28              | 31                             | 30              | 31                                | 30              | 31                                 | 31              | 30                           | 31              | 30              | 31                   |
| -----                                                                               |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| 4. Water heating energy requirements (kWh/year)                                     |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| -----                                                                               |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| Assumed occupancy                                                                   |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 2.7301 (42)          |
| Hot water usage for mixer showers                                                   | 96.2420         | 94.7956         | 92.6880                        | 88.6556         | 85.6797                           | 82.3610         | 80.4747                            | 82.5663         | 84.8591                      | 88.4224         | 92.5415         | 95.8732 (42a)        |
| Hot water usage for baths                                                           | 30.2230         | 29.7741         | 29.1421                        | 27.9766         | 27.1039                           | 26.1363         | 25.6136                            | 26.2413         | 26.9247                      | 27.9601         | 29.1495         | 30.1208 (42b)        |
| Hot water usage for other uses                                                      | 42.5887         | 41.0400         | 39.4913                        | 37.9426         | 36.3940                           | 34.8453         | 34.8453                            | 36.3940         | 37.9426                      | 39.4913         | 41.0400         | 42.5887 (42c)        |
| Average daily hot water use (litres/day)                                            |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 155.4703 (43)        |
| Daily hot water use                                                                 | Jan<br>169.0536 | Feb<br>165.6098 | Mar<br>161.3214                | Apr<br>154.5748 | May<br>149.1776                   | Jun<br>143.3426 | Jul<br>140.9336                    | Aug<br>145.2016 | Sep<br>149.7265              | Oct<br>155.8738 | Nov<br>162.7310 | Dec<br>168.5827 (44) |
| Energy conte                                                                        | 267.7396        | 235.8261        | 247.9450                       | 211.6052        | 200.8217                          | 176.2564        | 170.4470                           | 179.7899        | 184.6277                     | 211.5193        | 231.8402        | 263.9598 (45)        |
| Energy content (annual)                                                             |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 2582.3779            |
| Distribution loss (46)m = 0.15 x (45)m                                              | 40.1609         | 35.3739         | 37.1918                        | 31.7408         | 30.1233                           | 26.4385         | 25.5670                            | 26.9685         | 27.6942                      | 31.7279         | 34.7760         | 39.5940 (46)         |
| Water storage loss:                                                                 |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 200.0000 (47)        |
| Store volume                                                                        |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 1.8900 (48)          |
| a) If manufacturer declared loss factor is known (kWh/day):                         |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 0.5400 (49)          |
| Temperature factor from Table 2b                                                    |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 1.0206 (55)          |
| Enter (49) or (54) in (55)                                                          |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| Total storage loss                                                                  | 31.6386         | 28.5768         | 31.6386                        | 30.6180         | 31.6386                           | 30.6180         | 31.6386                            | 31.6386         | 30.6180                      | 31.6386         | 30.6180         | 31.6386 (56)         |
| If cylinder contains dedicated solar storage                                        | 31.6386         | 28.5768         | 31.6386                        | 30.6180         | 31.6386                           | 30.6180         | 31.6386                            | 31.6386         | 30.6180                      | 31.6386         | 30.6180         | 31.6386 (57)         |
| Primary loss                                                                        | 23.2624         | 21.0112         | 23.2624                        | 22.5120         | 23.2624                           | 22.5120         | 23.2624                            | 23.2624         | 22.5120                      | 23.2624         | 22.5120         | 23.2624 (59)         |
| Combi loss                                                                          | 0.0000          | 0.0000          | 0.0000                         | 0.0000          | 0.0000                            | 0.0000          | 0.0000                             | 0.0000          | 0.0000                       | 0.0000          | 0.0000          | 0.0000 (61)          |
| Total heat required for water heating calculated for each month                     | 322.6406        | 285.4141        | 302.8460                       | 264.7352        | 255.7227                          | 229.3864        | 225.3480                           | 234.6909        | 237.7577                     | 266.4203        | 284.9702        | 318.8608 (62)        |
| WWHRS                                                                               | 0.0000          | 0.0000          | 0.0000                         | 0.0000          | 0.0000                            | 0.0000          | 0.0000                             | 0.0000          | 0.0000                       | 0.0000          | 0.0000          | 0.0000 (63a)         |
| PV diverter                                                                         | -0.0000         | -0.0000         | -0.0000                        | -0.0000         | -0.0000                           | -0.0000         | -0.0000                            | -0.0000         | -0.0000                      | -0.0000         | -0.0000         | -0.0000 (63b)        |
| Solar input                                                                         | 0.0000          | 0.0000          | 0.0000                         | 0.0000          | 0.0000                            | 0.0000          | 0.0000                             | 0.0000          | 0.0000                       | 0.0000          | 0.0000          | 0.0000 (63c)         |
| FGHRS                                                                               | 0.0000          | 0.0000          | 0.0000                         | 0.0000          | 0.0000                            | 0.0000          | 0.0000                             | 0.0000          | 0.0000                       | 0.0000          | 0.0000          | 0.0000 (63d)         |
| Output from w/h                                                                     | 322.6406        | 285.4141        | 302.8460                       | 264.7352        | 255.7227                          | 229.3864        | 225.3480                           | 234.6909        | 237.7577                     | 266.4203        | 284.9702        | 318.8608 (64)        |
| 12Total per year (kWh/year)                                                         |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 3228.7929 (64)       |
| Electric shower(s)                                                                  | 0.0000          | 0.0000          | 0.0000                         | 0.0000          | 0.0000                            | 0.0000          | 0.0000                             | 0.0000          | 0.0000                       | 0.0000          | 0.0000          | 0.0000 (64a)         |
| Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m =      |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 0.0000 (64a)         |
| Heat gains from water heating, kWh/month                                            | 132.9442        | 118.0826        | 126.3625                       | 112.8627        | 110.6940                          | 101.1093        | 100.5944                           | 103.7009        | 103.8927                     | 114.2510        | 119.5909        | 131.6874 (65)        |
| -----                                                                               |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| 5. Internal gains (see Table 5 and 5a)                                              |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| -----                                                                               |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| Metabolic gains (Table 5), Watts                                                    | Jan<br>136.5037 | Feb<br>136.5037 | Mar<br>136.5037                | Apr<br>136.5037 | May<br>136.5037                   | Jun<br>136.5037 | Jul<br>136.5037                    | Aug<br>136.5037 | Sep<br>136.5037              | Oct<br>136.5037 | Nov<br>136.5037 | Dec<br>136.5037 (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     | 128.6625        | 142.4477        | 128.6625                       | 132.9512        | 128.6625                          | 132.9512        | 128.6625                           | 128.6625        | 132.9512                     | 128.6625        | 132.9512        | 128.6625 (67)        |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | 254.7009        | 257.3439        | 250.6836                       | 236.5047        | 218.6064                          | 201.7844        | 190.5464                           | 187.9034        | 194.5636                     | 208.7426        | 226.6409        | 243.4628 (68)        |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    | 36.6504         | 36.6504         | 36.6504                        | 36.6504         | 36.6504                           | 36.6504         | 36.6504                            | 36.6504         | 36.6504                      | 36.6504         | 36.6504         | 36.6504 (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)                                 | -109.2030       | -109.2030       | -109.2030                      | -109.2030       | -109.2030                         | -109.2030       | -109.2030                          | -109.2030       | -109.2030                    | -109.2030       | -109.2030       | -109.2030 (71)       |
| Water heating gains (Table 5)                                                       | 178.6885        | 175.7181        | 169.8421                       | 156.7538        | 148.7823                          | 140.4295        | 135.2075                           | 139.3830        | 144.2954                     | 153.5631        | 166.0984        | 176.9992 (72)        |
| Total internal gains                                                                | 626.0030        | 639.4609        | 613.1393                       | 590.1608        | 560.0022                          | 539.1163        | 518.3675                           | 519.8999        | 535.7614                     | 554.9192        | 589.6416        | 613.0756 (73)        |
| -----                                                                               |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| 6. Solar gains                                                                      |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| -----                                                                               |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| [Jan]                                                                               | Area<br>m2      |                 | Solar flux<br>Table 6a<br>W/m2 |                 | g<br>Specific data<br>or Table 6b |                 | FF<br>Specific data<br>or Table 6c |                 | Access<br>factor<br>Table 6d |                 | Gains<br>W      |                      |
| Northeast                                                                           | 4.0000          |                 | 11.2829                        |                 | 0.6300                            |                 | 0.7000                             |                 | 0.7700                       |                 | 13.7929 (75)    |                      |
| Southeast                                                                           | 8.1000          |                 | 36.7938                        |                 | 0.6300                            |                 | 0.7000                             |                 | 0.7700                       |                 | 91.0819 (77)    |                      |
| Northwest                                                                           | 9.1000          |                 | 11.2829                        |                 | 0.6300                            |                 | 0.7000                             |                 | 0.7700                       |                 | 31.3787 (81)    |                      |
| Solar gains                                                                         | 136.2535        | 247.0942        | 377.9389                       | 535.0856        | 660.3134                          | 682.3583        | 646.7050                           | 549.1791        | 431.7126                     | 283.8373        | 165.9326        | 114.8365 (83)        |
| Total gains                                                                         | 762.2564        | 886.5551        | 991.0782                       | 1125.2464       | 1220.3156                         | 1221.4746       | 1165.0724                          | 1069.0790       | 967.4740                     | 838.7566        | 755.5743        | 727.9121 (84)        |
| -----                                                                               |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| 7. Mean internal temperature (heating season)                                       |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| -----                                                                               |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| Temperature during heating periods in the living area from Table 9, Th1 (C)         |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 | 21.0000 (85)         |
| Utilisation factor for gains for living area, nil,m (see Table 9a)                  |                 |                 |                                |                 |                                   |                 |                                    |                 |                              |                 |                 |                      |
| tau                                                                                 | Jan<br>68.1080  | Feb<br>68.3904  | Mar<br>68.6752                 | Apr<br>68.6960  | May<br>68.6960                    | Jun<br>68.6960  | Jul<br>68.6960                     | Aug<br>68.6960  | Sep<br>68.6960               | Oct<br>68.6960  | Nov<br>68.6960  | Dec<br>68.6960       |
| alpha                                                                               | 5.5405          | 5.5594          | 5.5783                         | 5.5797          | 5.5797                            | 5.5797          | 5.5797                             | 5.5797          | 5.5797                       | 5.5797          | 5.5797          | 5.5797               |

# Full SAP Calculation Printout



|                                                                                                      |           |           |           |           |          |          |          |          |                           |               |           |                  |
|------------------------------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|---------------------------|---------------|-----------|------------------|
| util living area                                                                                     | 0.9932    | 0.9838    | 0.9589    | 0.8773    | 0.7147   | 0.5175   | 0.3769   | 0.4284   | 0.6788                    | 0.9232        | 0.9846    | 0.9947 (86)      |
| Living                                                                                               | 19.9700   | 20.1716   | 20.4432   | 20.7514   | 20.9349  | 20.9906  | 20.9987  | 20.9973  | 20.9625                   | 20.7040       | 20.2810   | 19.9365          |
| Non living                                                                                           | 18.8771   | 19.1344   | 19.4745   | 19.8361   | 20.0240  | 20.0693  | 20.0739  | 20.0734  | 20.0511                   | 19.7926       | 19.2778   | 18.8399          |
| 24 / 16                                                                                              | 0         | 0         | 0         | 0         | 0        | 0        | 0        | 0        | 0                         | 0             | 0         | 0                |
| 24 / 9                                                                                               | 3         | 0         | 0         | 0         | 0        | 0        | 0        | 0        | 0                         | 0             | 0         | 0                |
| 16 / 9                                                                                               | 28        | 0         | 0         | 0         | 0        | 0        | 0        | 0        | 0                         | 0             | 0         | 10               |
| MIT                                                                                                  | 20.4731   | 20.1716   | 20.4432   | 20.7514   | 20.9349  | 20.9906  | 20.9987  | 20.9973  | 20.9625                   | 20.7040       | 20.2810   | 20.0853 (87)     |
| Th 2                                                                                                 | 20.0670   | 20.0705   | 20.0740   | 20.0743   | 20.0743  | 20.0743  | 20.0743  | 20.0743  | 20.0743                   | 20.0743       | 20.0743   | 20.0743 (88)     |
| util rest of house                                                                                   | 0.9911    | 0.9789    | 0.9468    | 0.8454    | 0.6579   | 0.4457   | 0.2982   | 0.3434   | 0.6012                    | 0.8949        | 0.9790    | 0.9930 (89)      |
| MIT 2                                                                                                | 19.5926   | 19.1344   | 19.4745   | 19.8361   | 20.0240  | 20.0693  | 20.0739  | 20.0734  | 20.0511                   | 19.7926       | 19.2778   | 19.0624 (90)     |
| Living area fraction                                                                                 |           |           |           |           |          |          |          |          | fLA = Living area / (4) = |               |           | 0.2929 (91)      |
| MIT                                                                                                  | 19.8505   | 19.4382   | 19.7583   | 20.1043   | 20.2909  | 20.3392  | 20.3448  | 20.3440  | 20.3181                   | 20.0595       | 19.5717   | 19.3620 (92)     |
| Temperature adjustment                                                                               |           |           |           |           |          |          |          |          |                           |               |           | 0.0000           |
| adjusted MIT                                                                                         | 19.8505   | 19.4382   | 19.7583   | 20.1043   | 20.2909  | 20.3392  | 20.3448  | 20.3440  | 20.3181                   | 20.0595       | 19.5717   | 19.3620 (93)     |
| -----                                                                                                |           |           |           |           |          |          |          |          |                           |               |           |                  |
| 8. Space heating requirement                                                                         |           |           |           |           |          |          |          |          |                           |               |           |                  |
| -----                                                                                                |           |           |           |           |          |          |          |          |                           |               |           |                  |
|                                                                                                      | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep                       | Oct           | Nov       | Dec              |
| Utilisation                                                                                          | 0.9905    | 0.9746    | 0.9418    | 0.8465    | 0.6718   | 0.4665   | 0.3213   | 0.3683   | 0.6225                    | 0.8943        | 0.9751    | 0.9913 (94)      |
| Useful gains                                                                                         | 755.0270  | 864.0463  | 933.4210  | 952.5514  | 819.7761 | 569.8230 | 374.3163 | 393.7530 | 602.2691                  | 750.1242      | 736.7619  | 721.5770 (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                                                                                     | 1569.7116 | 1461.4680 | 1327.2740 | 1121.3064 | 859.7622 | 574.3718 | 374.7702 | 394.7131 | 622.2941                  | 946.6984      | 1248.1460 | 1517.3922 (97)   |
| Space heating kWh                                                                                    | 606.1253  | 401.4673  | 293.0266  | 121.5036  | 29.7496  | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 146.2512      | 368.1965  | 592.0865 (98a)   |
| Space heating requirement - total per year (kWh/year)                                                |           |           |           |           |          |          |          |          |                           |               |           | 2558.4067        |
| Solar heating kWh                                                                                    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (98b)     |
| Solar heating contribution - total per year (kWh/year)                                               |           |           |           |           |          |          |          |          |                           |               |           | 0.0000           |
| Space heating kWh                                                                                    | 606.1253  | 401.4673  | 293.0266  | 121.5036  | 29.7496  | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 146.2512      | 368.1965  | 592.0865 (98c)   |
| Space heating requirement after solar contribution - total per year (kWh/year)                       |           |           |           |           |          |          |          |          |                           |               |           | 2558.4067        |
| Space heating per m2                                                                                 |           |           |           |           |          |          |          |          |                           | (98c) / (4) = |           | 25.8425 (99)     |
| -----                                                                                                |           |           |           |           |          |          |          |          |                           |               |           |                  |
| 9a. Energy requirements - Individual heating systems, including micro-CHP                            |           |           |           |           |          |          |          |          |                           |               |           |                  |
| -----                                                                                                |           |           |           |           |          |          |          |          |                           |               |           |                  |
| Fraction of space heat from secondary/supplementary system (Table 11)                                |           |           |           |           |          |          |          |          |                           |               |           | 0.0000 (201)     |
| Fraction of space heat from main system(s)                                                           |           |           |           |           |          |          |          |          |                           |               |           | 1.0000 (202)     |
| Efficiency of main space heating system 1 (in %)                                                     |           |           |           |           |          |          |          |          |                           |               |           | 307.6511 (206)   |
| Efficiency of main space heating system 2 (in %)                                                     |           |           |           |           |          |          |          |          |                           |               |           | 0.0000 (207)     |
| Efficiency of secondary/supplementary heating system, %                                              |           |           |           |           |          |          |          |          |                           |               |           | 0.0000 (208)     |
|                                                                                                      | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep                       | Oct           | Nov       | Dec              |
| Space heating requirement                                                                            | 606.1253  | 401.4673  | 293.0266  | 121.5036  | 29.7496  | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 146.2512      | 368.1965  | 592.0865 (98)    |
| Space heating efficiency (main heating system 1)                                                     | 307.6511  | 307.6511  | 307.6511  | 307.6511  | 307.6511 | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 307.6511      | 307.6511  | 307.6511 (210)   |
| Space heating fuel (main heating system)                                                             | 197.0171  | 130.4944  | 95.2464   | 39.4940   | 9.6699   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 47.5380       | 119.6799  | 192.4539 (211)   |
| Space heating efficiency (main heating system 2)                                                     | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (212)     |
| Space heating fuel (main heating system 2)                                                           | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (213)     |
| Space heating fuel (secondary)                                                                       | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (215)     |
| Water heating                                                                                        |           |           |           |           |          |          |          |          |                           |               |           |                  |
| Water heating requirement                                                                            | 322.6406  | 285.4141  | 302.8460  | 264.7352  | 255.7227 | 229.3864 | 225.3480 | 234.6909 | 237.7577                  | 266.4203      | 284.9702  | 318.8608 (64)    |
| Efficiency of water heater (217)m                                                                    | 163.6100  | 163.6100  | 163.6100  | 163.6100  | 163.6100 | 163.6100 | 163.6100 | 163.6100 | 163.6100                  | 163.6100      | 163.6100  | 163.6100 (216)   |
| Fuel for water heating, kWh/month                                                                    | 197.2010  | 174.4478  | 185.1024  | 161.8087  | 156.3002 | 140.2032 | 137.7348 | 143.4453 | 145.3198                  | 162.8386      | 174.1765  | 194.8908 (219)   |
| Space cooling fuel requirement                                                                       |           |           |           |           |          |          |          |          |                           |               |           |                  |
| (221)m                                                                                               | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (221)     |
| Pumps and Fa                                                                                         | 2.3565    | 2.1284    | 2.3565    | 2.2805    | 2.3565   | 2.2805   | 2.3565   | 2.3565   | 2.2805                    | 2.3565        | 2.2805    | 2.3565 (231)     |
| Lighting                                                                                             | 33.2371   | 26.6640   | 24.0080   | 17.5893   | 13.5865  | 11.1003  | 12.3940  | 16.1103  | 20.9256                   | 27.4555       | 31.0110   | 34.1609 (232)    |
| Electricity generated by PVs (Appendix M) (negative quantity)                                        | -31.7425  | -47.9557  | -73.4758  | -86.8096  | -97.0661 | -91.6669 | -90.4015 | -83.2518 | -70.7309                  | -56.1191      | -35.7780  | -27.0313 (233a)  |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (234a)    |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (235a)    |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (235c)    |
| Electricity generated by PVs (Appendix M) (negative quantity)                                        | -8.3267   | -18.9083  | -40.4012  | -65.8080  | -91.4802 | -93.7041 | -92.5197 | -76.5674 | -54.4395                  | -29.3576      | -11.7499  | -6.4998 (233b)   |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (234b)    |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (235b)    |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000                    | 0.0000        | 0.0000    | 0.0000 (235d)    |
| Annual totals kWh/year                                                                               |           |           |           |           |          |          |          |          |                           |               |           |                  |
| Space heating fuel - main system 1                                                                   |           |           |           |           |          |          |          |          |                           |               |           | 831.5937 (211)   |
| Space heating fuel - main system 2                                                                   |           |           |           |           |          |          |          |          |                           |               |           | 0.0000 (213)     |
| Space heating fuel - secondary                                                                       |           |           |           |           |          |          |          |          |                           |               |           | 0.0000 (215)     |
| Efficiency of water heater                                                                           |           |           |           |           |          |          |          |          |                           |               |           | 163.6100         |
| Water heating fuel used                                                                              |           |           |           |           |          |          |          |          |                           |               |           | 1973.4690 (219)  |
| Space cooling fuel                                                                                   |           |           |           |           |          |          |          |          |                           |               |           | 0.0000 (221)     |
| Electricity for pumps and fans:                                                                      |           |           |           |           |          |          |          |          |                           |               |           |                  |
| (MEV)Decentralised, Database: total watage = 3.5880, total flow = 39.0000, SFP = 0.0920)             |           |           |           |           |          |          |          |          |                           |               |           |                  |
| mechanical ventilation fans (SFP = 0.0920)                                                           |           |           |           |           |          |          |          |          |                           |               |           | 27.7457 (230a)   |
| Total electricity for the above, kWh/year                                                            |           |           |           |           |          |          |          |          |                           |               |           | 27.7457 (231)    |
| Electricity for lighting (calculated in Appendix L)                                                  |           |           |           |           |          |          |          |          |                           |               |           | 268.2426 (232)   |
| Energy saving/generation technologies (Appendices M ,N and Q)                                        |           |           |           |           |          |          |          |          |                           |               |           |                  |
| PV generation                                                                                        |           |           |           |           |          |          |          |          |                           |               |           | -1381.7915 (233) |
| Wind generation                                                                                      |           |           |           |           |          |          |          |          |                           |               |           | 0.0000 (234)     |
| Hydro-electric generation (Appendix N)                                                               |           |           |           |           |          |          |          |          |                           |               |           | 0.0000 (235a)    |
| Electricity generated - Micro CHP (Appendix N)                                                       |           |           |           |           |          |          |          |          |                           |               |           | 0.0000 (235)     |

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## Appendix Q - special features

|                                     |                 |
|-------------------------------------|-----------------|
| Energy saved or generated           | -0.0000 (236)   |
| Energy used                         | 0.0000 (237)    |
| Total delivered energy for all uses | 1719.2594 (238) |

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

|                                                         | Energy<br>kWh/year | Emission factor<br>kg CO <sub>2</sub> /kWh | Emissions<br>kg CO <sub>2</sub> /year |
|---------------------------------------------------------|--------------------|--------------------------------------------|---------------------------------------|
| Space heating - main system 1                           | 831.5937           | 0.1568                                     | 130.3965 (261)                        |
| Total CO <sub>2</sub> associated with community systems |                    |                                            | 0.0000 (373)                          |
| Water heating (other fuel)                              | 1973.4690          | 0.1410                                     | 278.2681 (264)                        |
| Space and water heating                                 |                    |                                            | 408.6646 (265)                        |
| Pumps, fans and electric keep-hot                       | 27.7457            | 0.1387                                     | 3.8487 (267)                          |
| Energy for lighting                                     | 268.2426           | 0.1443                                     | 38.7157 (268)                         |
| Energy saving/generation technologies                   |                    |                                            |                                       |
| PV Unit electricity used in dwelling                    | -792.0291          | 0.1335                                     | -105.7440                             |
| PV Unit electricity exported                            | -589.7624          | 0.1238                                     | -73.0355                              |
| Total                                                   |                    |                                            | -178.7795 (269)                       |
| Total CO <sub>2</sub> , kg/year                         |                    |                                            | 272.4495 (272)                        |
| EPC Dwelling Carbon Dioxide Emission Rate (DER)         |                    |                                            | 2.7500 (273)                          |

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

|                                                         | Energy<br>kWh/year | Primary energy factor<br>kg CO <sub>2</sub> /kWh | Primary energy<br>kWh/year |
|---------------------------------------------------------|--------------------|--------------------------------------------------|----------------------------|
| Space heating - main system 1                           | 831.5937           | 1.5805                                           | 1314.3049 (275)            |
| Total CO <sub>2</sub> associated with community systems |                    |                                                  | 0.0000 (473)               |
| Water heating (other fuel)                              | 1973.4690          | 1.5214                                           | 3002.4140 (278)            |
| Space and water heating                                 |                    |                                                  | 4316.7188 (279)            |
| Pumps, fans and electric keep-hot                       | 27.7457            | 1.5128                                           | 41.9737 (281)              |
| Energy for lighting                                     | 268.2426           | 1.5338                                           | 411.4394 (282)             |
| Energy saving/generation technologies                   |                    |                                                  |                            |
| PV Unit electricity used in dwelling                    | -792.0291          | 1.4934                                           | -1182.7962                 |
| PV Unit electricity exported                            | -589.7624          | 0.4545                                           | -268.0367                  |
| Total                                                   |                    |                                                  | -1450.8329 (283)           |
| Total Primary energy kWh/year                           |                    |                                                  | 3319.2991 (286)            |
| Dwelling Primary energy Rate (DPER)                     |                    |                                                  | 33.5300 (287)              |

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

### 1. Overall dwelling characteristics

|                                                        | Area<br>(m <sup>2</sup> ) | Storey height<br>(m)                        | Volume<br>(m <sup>3</sup> ) |
|--------------------------------------------------------|---------------------------|---------------------------------------------|-----------------------------|
| Ground floor                                           | 35.0000 (1b)              | x 2.4000 (2b)                               | = 84.0000 (1b) - (3b)       |
| First floor                                            | 32.0000 (1c)              | x 2.6000 (2c)                               | = 83.2000 (1c) - (3c)       |
| Second floor                                           | 32.0000 (1d)              | x 2.5000 (2d)                               | = 80.0000 (1d) - (3d)       |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)...(1n) | 99.0000                   |                                             | (4)                         |
| Dwelling volume                                        |                           | (3a) + (3b) + (3c) + (3d) + (3e) ... (3n) = | 247.2000 (5)                |

### 2. Ventilation rate

|                                                                                                    | m <sup>3</sup> per hour                 |
|----------------------------------------------------------------------------------------------------|-----------------------------------------|
| Number of open chimneys                                                                            | 0 * 80 = 0.0000 (6a)                    |
| Number of open flues                                                                               | 0 * 20 = 0.0000 (6b)                    |
| Number of chimneys / flues attached to closed fire                                                 | 0 * 10 = 0.0000 (6c)                    |
| Number of flues attached to solid fuel boiler                                                      | 0 * 20 = 0.0000 (6d)                    |
| Number of flues attached to other heater                                                           | 0 * 35 = 0.0000 (6e)                    |
| Number of blocked chimneys                                                                         | 0 * 20 = 0.0000 (6f)                    |
| Number of intermittent extract fans                                                                | 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)+(6c)+(6d)+(6e)+(6f)+(6g)+(7a)+(7b)+(7c) = | 30.0000 / (5) = 0.1214 (8)              |
| Pressure test                                                                                      | Yes                                     |
| Pressure Test Method                                                                               | Blower Door                             |
| Measured/design AP50                                                                               | 5.0000 (17)                             |
| Infiltration rate                                                                                  | 0.3714 (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) = 0.3157 (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 | 0.4025 | 0.3946 | 0.3867 | 0.3472 | 0.3393 | 0.2999 | 0.2999 | 0.2920 | 0.3157 | 0.3393 | 0.3551 | 0.3709 (22b) |
| Effective ac    | 0.5810 | 0.5778 | 0.5748 | 0.5603 | 0.5576 | 0.5450 | 0.5450 | 0.5426 | 0.5498 | 0.5576 | 0.5631 | 0.5688 (25)  |

# Full SAP Calculation Printout



## 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                                |             |                | 1.8900        | 1.0000                | 1.8900       |                   |               | (26)  |
| TER Opening Type (Uw = 1.20)                   |             |                | 21.2000       | 1.1450                | 24.2748      |                   |               | (27)  |
| Heat Loss Floor 1                              |             |                | 35.0000       | 0.1300                | 4.5500       |                   |               | (28a) |
| External Wall 1                                | 115.6000    | 23.0900        | 92.5100       | 0.1800                | 16.6518      |                   |               | (29a) |
| External Roof 1                                | 8.3000      |                | 8.3000        | 0.1100                | 0.9130       |                   |               | (30)  |
| Roof ceiling                                   | 24.0000     |                | 24.0000       | 0.1100                | 2.6400       |                   |               | (30)  |
| Total net area of external elements Aum(A, m2) |             |                | 182.9000      |                       |              |                   |               | (31)  |
| Fabric heat loss, W/K = Sum (A x U)            |             |                |               | (26)... (30) + (32) = | 50.9196      |                   |               | (33)  |
| Party Wall 1                                   |             |                | 66.7000       | 0.0000                | 0.0000       |                   |               | (32)  |

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

250.0000 (35)

List of Thermal Bridges

|                                                            | Length  | Psi-value | Total  |                                    |
|------------------------------------------------------------|---------|-----------|--------|------------------------------------|
| K1 Element                                                 | 13.4000 | 0.0500    | 0.6700 |                                    |
| E2 Other lintels (including other steel lintels)           | 12.5000 | 0.0500    | 0.6250 |                                    |
| E3 Sill                                                    | 55.6000 | 0.0500    | 2.7800 |                                    |
| E4 Jamb                                                    | 17.0000 | 0.1600    | 2.7200 |                                    |
| E5 Ground floor (normal)                                   | 32.0000 | 0.0000    | 0.0000 |                                    |
| E6 Intermediate floor within a dwelling                    | 15.0000 | 0.0900    | 1.3500 |                                    |
| E16 Corner (normal)                                        | 15.0000 | 0.0600    | 0.9000 |                                    |
| E18 Party wall between dwellings                           |         |           |        | 9.0450 (36)                        |
| Thermal bridges (Sum(L x Psi) calculated using Appendix K) |         |           |        | 0.0000                             |
| Point Thermal bridges                                      |         |           |        | (36a) =                            |
| Total fabric heat loss                                     |         |           |        | (33) + (36) + (36a) = 59.9646 (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       | 47.3946  | 47.1381  | 46.8866  | 45.7055  | 45.4845  | 44.4558  | 44.4558  | 44.2653  | 44.8520  | 45.4845  | 45.9316  | 46.3989  | (38) |
| Average = Sum(39)m / 12 = | 107.3592 | 107.1027 | 106.8512 | 105.6701 | 105.4491 | 104.4204 | 104.4204 | 104.2299 | 104.8167 | 105.4491 | 105.8962 | 106.3635 | (39) |
|                           |          |          |          |          |          |          |          |          |          |          |          | 105.6690 |      |
| HLP                       | 1.0844   | 1.0818   | 1.0793   | 1.0674   | 1.0651   | 1.0548   | 1.0548   | 1.0528   | 1.0588   | 1.0651   | 1.0697   | 1.0744   | (40) |
| HLP (average)             |          |          |          |          |          |          |          |          |          |          |          | 1.0674   |      |
| Days in mont              | 31       | 28       | 31       | 30       | 31       | 30       | 31       | 31       | 30       | 31       | 30       | 31       |      |

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

|                                                                                |          |          |          |          |          |          |          |          |          |          |          |           |             |
|--------------------------------------------------------------------------------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|----------|-----------|-------------|
| Assumed occupancy                                                              |          |          |          |          |          |          |          |          |          |          |          |           | 2.7301 (42) |
| Hot water usage for mixer showers                                              |          |          |          |          |          |          |          |          |          |          |          |           |             |
| 69.9941                                                                        | 68.9423  | 67.4095  | 64.4768  | 62.3125  | 59.8989  | 58.5270  | 60.0482  | 61.7157  | 64.3072  | 67.3029  | 69.7260  | 69.7260   | (42a)       |
| Hot water usage for baths                                                      |          |          |          |          |          |          |          |          |          |          |          |           |             |
| 30.2230                                                                        | 29.7741  | 29.1421  | 27.9766  | 27.1039  | 26.1363  | 25.6136  | 26.2413  | 26.9247  | 27.9601  | 29.1495  | 30.1208  | 30.1208   | (42b)       |
| Hot water usage for other uses                                                 |          |          |          |          |          |          |          |          |          |          |          |           |             |
| 42.5887                                                                        | 41.0400  | 39.4913  | 37.9426  | 36.3940  | 34.8453  | 34.8453  | 36.3940  | 37.9426  | 39.4913  | 41.0400  | 42.5887  | 42.5887   | (42c)       |
| Average daily hot water use (litres/day)                                       |          |          |          |          |          |          |          |          |          |          |          | 131.2707  | (43)        |
| Daily hot water use                                                            |          |          |          |          |          |          |          |          |          |          |          |           |             |
| 142.8058                                                                       | 139.7564 | 136.0429 | 130.3960 | 125.8104 | 120.8805 | 118.9860 | 122.6835 | 126.5831 | 131.7586 | 137.4924 | 142.4355 | 142.4355  | (44)        |
| Energy conte                                                                   | 226.1695 | 199.0113 | 209.0928 | 178.5056 | 169.3650 | 148.6367 | 143.9032 | 151.9078 | 156.0896 | 178.7952 | 195.8832 | 223.0195  | (45)        |
| Energy content (annual)                                                        |          |          |          |          |          |          |          |          |          |          |          | 2180.3794 |             |
| Distribution loss (46)m = 0.15 x (45)m                                         |          |          |          |          |          |          |          |          |          |          |          |           |             |
| 33.9254                                                                        | 29.8517  | 31.3639  | 26.7758  | 25.4047  | 22.2955  | 21.5855  | 22.7862  | 23.4134  | 26.8193  | 29.3825  | 33.4529  | 33.4529   | (46)        |
| Water storage loss:                                                            |          |          |          |          |          |          |          |          |          |          |          |           |             |
| Store volume                                                                   |          |          |          |          |          |          |          |          |          |          |          | 200.0000  | (47)        |
| a) If manufacturer declared loss factor is known (kWh/day):                    |          |          |          |          |          |          |          |          |          |          |          | 1.6525    | (48)        |
| Temperature factor from Table 2b                                               |          |          |          |          |          |          |          |          |          |          |          | 0.5400    | (49)        |
| Enter (49) or (54) in (55)                                                     |          |          |          |          |          |          |          |          |          |          |          | 0.8924    | (55)        |
| Total storage loss                                                             |          |          |          |          |          |          |          |          |          |          |          |           |             |
| 27.6637                                                                        | 24.9865  | 27.6637  | 26.7713  | 27.6637  | 26.7713  | 27.6637  | 27.6637  | 26.7713  | 27.6637  | 26.7713  | 27.6637  | 27.6637   | (56)        |
| If cylinder contains dedicated solar storage                                   |          |          |          |          |          |          |          |          |          |          |          |           |             |
| 27.6637                                                                        | 24.9865  | 27.6637  | 26.7713  | 27.6637  | 26.7713  | 27.6637  | 27.6637  | 26.7713  | 27.6637  | 26.7713  | 27.6637  | 27.6637   | (57)        |
| Primary loss                                                                   | 23.2624  | 21.0112  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 22.5120  | 23.2624  | 23.2624   | (59)        |
| Combi loss                                                                     | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (61)        |
| Total heat required for water heating calculated for each month                |          |          |          |          |          |          |          |          |          |          |          |           |             |
| 277.0956                                                                       | 245.0090 | 260.0189 | 227.7889 | 220.2911 | 197.9200 | 194.8293 | 202.8338 | 205.3729 | 229.7213 | 245.1665 | 273.9456 | 273.9456  | (62)        |
| WWHRS                                                                          | -31.9984 | -28.2996 | -29.6338 | -24.5379 | -22.8685 | -19.5687 | -18.3425 | -19.5055 | -20.2465 | -23.8684 | -27.0400 | -31.4058  | (63a)       |
| PV diverter                                                                    | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000  | -0.0000   | (63b)       |
| Solar input                                                                    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (63c)       |
| FGHRS                                                                          | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (63d)       |
| Output from w/h                                                                | 245.0972 | 216.7094 | 230.3851 | 203.2510 | 197.4226 | 178.3513 | 176.4867 | 183.3284 | 185.1263 | 205.8528 | 218.1265 | 242.5398  | (64)        |
| 12Total per year (kWh/year)                                                    |          |          |          |          |          |          |          |          |          |          |          | 2482.6771 | (64)        |
| Electric shower(s)                                                             |          |          |          |          |          |          |          |          |          |          |          | 2483      | (64)        |
| 0.0000                                                                         | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | (64a)       |
| Total Energy used by instantaneous electric shower(s) (kWh/year) = Sum(64a)m = |          |          |          |          |          |          |          |          |          |          |          | 0.0000    | (64a)       |
| Heat gains from water heating, kWh/month                                       |          |          |          |          |          |          |          |          |          |          |          |           |             |
| 115.9422                                                                       | 102.9694 | 110.2642 | 98.7798  | 97.0547  | 88.8483  | 88.5887  | 91.2502  | 91.3264  | 100.1903 | 104.5578 | 114.8949 | 114.8949  | (65)        |

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

|                                                                                     |           |           |           |           |           |           |           |           |           |           |           |           |      |
|-------------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|------|
| Metabolic gains (Table 5), Watts                                                    |           |           |           |           |           |           |           |           |           |           |           |           |      |
| (66)m                                                                               | 136.5037  | 136.5037  | 136.5037  | 136.5037  | 136.5037  | 136.5037  | 136.5037  | 136.5037  | 136.5037  | 136.5037  | 136.5037  | 136.5037  | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5     |           |           |           |           |           |           |           |           |           |           |           |           |      |
| 128.6625                                                                            | 142.4477  | 128.6625  | 132.9512  | 128.6625  | 132.9512  | 128.6625  | 128.6625  | 132.9512  | 128.6625  | 132.9512  | 128.6625  | 128.6625  | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 |           |           |           |           |           |           |           |           |           |           |           |           |      |
| 254.7009                                                                            | 257.3439  | 250.6836  | 236.5047  | 218.6064  | 201.7844  | 190.5464  | 187.9034  | 194.5636  | 208.7426  | 226.6409  | 243.4628  | 243.4628  | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5    |           |           |           |           |           |           |           |           |           |           |           |           |      |
| 36.6504                                                                             | 36.6504   | 36.6504   | 36.6504   | 36.6504   | 36.6504   | 36.6504   | 36.6504   | 36.6504   | 36.6504   | 36.6504   | 36.6504   | 36.6504   | (69) |
| Pumps, fans                                                                         | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 3.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 3.0000    | 3.0000    | 3.0000    | (70) |
| Losses e.g. evaporation (negative values) (Table 5)                                 |           |           |           |           |           |           |           |           |           |           |           |           |      |
| -109.2030                                                                           | -109.2030 | -109.2030 | -109.2030 | -109.2030 | -109.2030 | -109.2030 | -109.2030 | -109.2030 | -109.2030 | -109.2030 | -109.2030 | -109.2030 | (71) |
| Water heating gains (Table 5)                                                       |           |           |           |           |           |           |           |           |           |           |           |           |      |
| 155.8363                                                                            | 153.2283  | 148.2046  | 137.1941  | 130.4499  | 123.4005  | 119.0708  | 122.6481  | 126.8423  | 134.6643  | 145.2192  | 154.4286  | 154.4286  | (72) |
| Total internal gains                                                                | 606.1508  | 619.9711  | 594.5018  | 573.6011  | 544.6698  | 522.0872  | 502.2307  | 503.1650  | 518.3082  | 539.0205  | 571.7624  | 593.5050  | (73) |

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## 6. Solar gains

| [Jan]       |          |          |          |           | Area<br>m2 | Solar flux<br>Table 6a<br>W/m2 | Specific data<br>or Table 6b | g         | Specific data<br>or Table 6c | FF       | Access<br>factor<br>Table 6d | Gains<br>W    |
|-------------|----------|----------|----------|-----------|------------|--------------------------------|------------------------------|-----------|------------------------------|----------|------------------------------|---------------|
| Northeast   |          |          |          |           | 4.0000     | 11.2829                        |                              | 0.6300    |                              | 0.7000   | 0.7700                       | 13.7929 (75)  |
| Southeast   |          |          |          |           | 8.1000     | 36.7938                        |                              | 0.6300    |                              | 0.7000   | 0.7700                       | 91.0819 (77)  |
| Northwest   |          |          |          |           | 9.1000     | 11.2829                        |                              | 0.6300    |                              | 0.7000   | 0.7700                       | 31.3787 (81)  |
| Solar gains | 136.2535 | 247.0942 | 377.9389 | 535.0856  | 660.3134   | 682.3583                       | 646.7050                     | 549.1791  | 431.7126                     | 283.8373 | 165.9326                     | 114.8365 (83) |
| Total gains | 742.4043 | 867.0653 | 972.4407 | 1108.6868 | 1204.9832  | 1204.4455                      | 1148.9357                    | 1052.3442 | 950.0208                     | 822.8578 | 737.6950                     | 708.3415 (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                                                                         | 64.0373                   | 64.1907 | 64.3418 | 65.0610 | 65.1973 | 65.8396 | 65.8396 | 65.9600 | 65.5907 | 65.1973 | 64.9221 | 64.6368      |
| alpha                                                                       | 5.2692                    | 5.2794  | 5.2895  | 5.3374  | 5.3465  | 5.3893  | 5.3893  | 5.3973  | 5.3727  | 5.3465  | 5.3281  | 5.3091       |
| util living area                                                            | 0.9944                    | 0.9866  | 0.9665  | 0.8956  | 0.7448  | 0.5443  | 0.3982  | 0.4520  | 0.7103  | 0.9359  | 0.9873  | 0.9955 (86)  |
| MIT                                                                         | 19.8442                   | 20.0474 | 20.3315 | 20.6860 | 20.9085 | 20.9860 | 20.9978 | 20.9958 | 20.9467 | 20.6408 | 20.1828 | 19.8124 (87) |
| Th 2                                                                        | 20.0136                   | 20.0157 | 20.0178 | 20.0276 | 20.0294 | 20.0380 | 20.0380 | 20.0395 | 20.0347 | 20.0294 | 20.0257 | 20.0218 (88) |
| util rest of house                                                          | 0.9925                    | 0.9825  | 0.9560  | 0.8659  | 0.6868  | 0.4671  | 0.3120  | 0.3595  | 0.6299  | 0.9103  | 0.9825  | 0.9941 (89)  |
| MIT 2                                                                       | 18.6775                   | 18.9365 | 19.2933 | 19.7231 | 19.9578 | 20.0305 | 20.0373 | 20.0381 | 20.0012 | 19.6833 | 19.1176 | 18.6430 (90) |
| Living area fraction                                                        | fLA = Living area / (4) = |         |         |         |         |         |         |         |         |         |         |              |
| MIT                                                                         | 19.0192                   | 19.2619 | 19.5974 | 20.0051 | 20.2363 | 20.3104 | 20.3187 | 20.3187 | 20.2782 | 19.9638 | 19.4297 | 18.9855 (92) |
| Temperature adjustment                                                      | 0.0000                    |         |         |         |         |         |         |         |         |         |         |              |
| adjusted MIT                                                                | 19.0192                   | 19.2619 | 19.5974 | 20.0051 | 20.2363 | 20.3104 | 20.3187 | 20.3187 | 20.2782 | 19.9638 | 19.4297 | 18.9855 (93) |

## 8. Space heating requirement

|                                                                                |           |           |           |           |          |          |          |          |          |          |           |                            |
|--------------------------------------------------------------------------------|-----------|-----------|-----------|-----------|----------|----------|----------|----------|----------|----------|-----------|----------------------------|
|                                                                                | Jan       | Feb       | Mar       | Apr       | May      | Jun      | Jul      | Aug      | Sep      | Oct      | Nov       | Dec                        |
| Utilisation                                                                    | 0.9900    | 0.9782    | 0.9505    | 0.8651    | 0.6999   | 0.4893   | 0.3373   | 0.3867   | 0.6513   | 0.9083   | 0.9787    | 0.9920 (94)                |
| Useful gains                                                                   | 734.9881  | 848.2059  | 924.3042  | 959.1375  | 843.3408 | 589.3952 | 387.5603 | 406.9292 | 618.7718 | 747.3844 | 721.9513  | 702.6646 (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                                                               | 1580.2459 | 1538.1980 | 1399.4748 | 1173.4815 | 900.1447 | 596.2822 | 388.3041 | 408.4441 | 647.5769 | 987.4048 | 1305.6645 | 1572.6423 (97)             |
| Space heating kWh                                                              | 628.8718  | 463.6746  | 353.5269  | 154.3277  | 42.2621  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 178.5752 | 420.2735  | 647.2634 (98a)             |
| Space heating requirement - total per year (kWh/year)                          |           |           |           |           |          |          |          |          |          |          |           | 2888.7753                  |
| Solar heating kWh                                                              | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000 (98b)               |
| Solar heating contribution - total per year (kWh/year)                         |           |           |           |           |          |          |          |          |          |          |           | 0.0000                     |
| Space heating kWh                                                              | 628.8718  | 463.6746  | 353.5269  | 154.3277  | 42.2621  | 0.0000   | 0.0000   | 0.0000   | 0.0000   | 178.5752 | 420.2735  | 647.2634 (98c)             |
| Space heating requirement after solar contribution - total per year (kWh/year) |           |           |           |           |          |          |          |          |          |          |           | 2888.7753                  |
| Space heating per m2                                                           |           |           |           |           |          |          |          |          |          |          |           | (98c) / (4) = 29.1795 (99) |

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

|                                                                                                      |          |          |          |           |           |           |           |           |          |          |          |                 |
|------------------------------------------------------------------------------------------------------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|----------|----------|----------|-----------------|
| Fraction of space heat from secondary/supplementary system (Table 11)                                |          |          |          |           |           |           |           |           |          |          |          | 0.0000 (201)    |
| Fraction of space heat from main system(s)                                                           |          |          |          |           |           |           |           |           |          |          |          | 1.0000 (202)    |
| Efficiency of main space heating system 1 (in %)                                                     |          |          |          |           |           |           |           |           |          |          |          | 92.3000 (206)   |
| Efficiency of main space heating system 2 (in %)                                                     |          |          |          |           |           |           |           |           |          |          |          | 0.0000 (207)    |
| Efficiency of secondary/supplementary heating system, %                                              |          |          |          |           |           |           |           |           |          |          |          | 0.0000 (208)    |
|                                                                                                      | Jan      | Feb      | Mar      | Apr       | May       | Jun       | Jul       | Aug       | Sep      | Oct      | Nov      | Dec             |
| Space heating requirement                                                                            | 628.8718 | 463.6746 | 353.5269 | 154.3277  | 42.2621   | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 178.5752 | 420.2735 | 647.2634 (98)   |
| Space heating efficiency (main heating system 1)                                                     | 92.3000  | 92.3000  | 92.3000  | 92.3000   | 92.3000   | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 92.3000  | 92.3000  | 92.3000 (210)   |
| Space heating fuel (main heating system)                                                             | 681.3346 | 502.3560 | 383.0194 | 167.2023  | 45.7878   | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 193.4726 | 455.3343 | 701.2604 (211)  |
| Space heating efficiency (main heating system 2)                                                     | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000 (212)    |
| Space heating fuel (main heating system 2)                                                           | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000 (213)    |
| Space heating fuel (secondary)                                                                       | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000 (215)    |
| Water heating                                                                                        |          |          |          |           |           |           |           |           |          |          |          |                 |
| Water heating requirement                                                                            | 245.0972 | 216.7094 | 230.3851 | 203.2510  | 197.4226  | 178.3513  | 176.4867  | 183.3284  | 185.1263 | 205.8528 | 218.1265 | 242.5398 (64)   |
| Efficiency of water heater                                                                           | 86.0775  | 85.7207  | 85.0169  | 83.4503   | 81.2520   | 79.8000   | 79.8000   | 79.8000   | 79.8000  | 83.7426  | 85.5051  | 79.8000 (216)   |
| Fuel for water heating, kWh/month                                                                    | 284.7402 | 252.8086 | 270.9876 | 243.5593  | 242.9756  | 223.4978  | 221.1613  | 229.7348  | 231.9879 | 245.8162 | 255.1035 | 281.5269 (219)  |
| Space cooling fuel 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 (221)    |
| Pumps and Fa                                                                                         | 7.3041   | 6.5973   | 7.3041   | 7.0685    | 7.3041    | 7.0685    | 7.3041    | 7.3041    | 7.0685   | 7.3041   | 7.0685   | 7.3041 (231)    |
| Lighting                                                                                             | 26.7335  | 21.4466  | 19.3103  | 14.1476   | 10.9280   | 8.9283    | 9.9689    | 12.9579   | 16.8310  | 22.0832  | 24.9430  | 27.4765 (232)   |
| Electricity generated by PVs (Appendix M) (negative quantity)                                        | -34.5761 | -49.7266 | -72.8929 | -83.6199  | -91.5653  | -85.9364  | -84.8409  | -79.3858  | -70.0226 | -57.5688 | -38.3450 | -29.7765 (233a) |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000 (234a)   |
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000 (235a)   |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000 (235c)   |
| Electricity generated by PVs (Appendix M) (negative quantity)                                        | -16.6708 | -35.3600 | -70.8308 | -107.2011 | -142.5618 | -143.5702 | -141.9202 | -119.8266 | -87.3579 | -50.8848 | -22.3574 | -13.1643 (233b) |
| Electricity generated by wind turbines (Appendix M) (negative quantity)                              | 0.0000   | 0.0000   | 0.0000   | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000    | 0.0000   | 0.0000   | 0.0000   | 0.0000 (234b)   |

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|                                                                                                      |                    |                                     |                            |        |        |        |        |        |                  |
|------------------------------------------------------------------------------------------------------|--------------------|-------------------------------------|----------------------------|--------|--------|--------|--------|--------|------------------|
| Electricity generated by hydro-electric generators (Appendix M) (negative quantity)                  |                    |                                     |                            |        |        |        |        |        |                  |
| (235b)m                                                                                              | 0.0000             | 0.0000                              | 0.0000                     | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 (235b)    |
| Electricity used or net electricity generated by micro-CHP (Appendix N) (negative if net generation) |                    |                                     |                            |        |        |        |        |        |                  |
| (235d)m                                                                                              | 0.0000             | 0.0000                              | 0.0000                     | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 (235d)    |
| Annual totals kWh/year                                                                               |                    |                                     |                            |        |        |        |        |        |                  |
| Space heating fuel - main system 1                                                                   |                    |                                     |                            |        |        |        |        |        | 3129.7674 (211)  |
| Space heating fuel - main system 2                                                                   |                    |                                     |                            |        |        |        |        |        | 0.0000 (213)     |
| Space heating fuel - secondary                                                                       |                    |                                     |                            |        |        |        |        |        | 0.0000 (215)     |
| Efficiency of water heater                                                                           |                    |                                     |                            |        |        |        |        |        | 79.8000          |
| Water heating fuel used                                                                              |                    |                                     |                            |        |        |        |        |        | 2983.8998 (219)  |
| Space cooling fuel                                                                                   |                    |                                     |                            |        |        |        |        |        | 0.0000 (221)     |
| Electricity for pumps and fans:                                                                      |                    |                                     |                            |        |        |        |        |        |                  |
| Total electricity for the above, kWh/year                                                            |                    |                                     |                            |        |        |        |        |        | 86.0000 (231)    |
| Electricity for lighting (calculated in Appendix L)                                                  |                    |                                     |                            |        |        |        |        |        | 215.7548 (232)   |
| Energy saving/generation technologies (Appendices M ,N and Q)                                        |                    |                                     |                            |        |        |        |        |        |                  |
| PV generation                                                                                        |                    |                                     |                            |        |        |        |        |        | -1729.9627 (233) |
| Wind generation                                                                                      |                    |                                     |                            |        |        |        |        |        | 0.0000 (234)     |
| Hydro-electric generation (Appendix N)                                                               |                    |                                     |                            |        |        |        |        |        | 0.0000 (235a)    |
| Electricity generated - Micro CHP (Appendix N)                                                       |                    |                                     |                            |        |        |        |        |        | 0.0000 (235)     |
| Appendix Q - special features                                                                        |                    |                                     |                            |        |        |        |        |        |                  |
| Energy saved or generated                                                                            |                    |                                     |                            |        |        |        |        |        | -0.0000 (236)    |
| Energy used                                                                                          |                    |                                     |                            |        |        |        |        |        | 0.0000 (237)     |
| Total delivered energy for all uses                                                                  |                    |                                     |                            |        |        |        |        |        | 4685.4593 (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                                                                        | 3129.7674          | 0.2100                              | 657.2511 (261)             |        |        |        |        |        |                  |
| Total CO2 associated with community systems                                                          |                    |                                     | 0.0000 (373)               |        |        |        |        |        |                  |
| Water heating (other fuel)                                                                           | 2983.8998          | 0.2100                              | 626.6190 (264)             |        |        |        |        |        |                  |
| Space and water heating                                                                              |                    |                                     | 1283.8701 (265)            |        |        |        |        |        |                  |
| Pumps, fans and electric keep-hot                                                                    | 86.0000            | 0.1387                              | 11.9293 (267)              |        |        |        |        |        |                  |
| Energy for lighting                                                                                  | 215.7548           | 0.1443                              | 31.1401 (268)              |        |        |        |        |        |                  |
| Energy saving/generation technologies                                                                |                    |                                     |                            |        |        |        |        |        |                  |
| PV Unit electricity used in dwelling                                                                 | -778.2568          | 0.1342                              | -104.4257                  |        |        |        |        |        |                  |
| PV Unit electricity exported                                                                         | -951.7059          | 0.1257                              | -119.5957                  |        |        |        |        |        |                  |
| Total                                                                                                |                    |                                     | -224.0215 (269)            |        |        |        |        |        |                  |
| Total CO2, kg/year                                                                                   |                    |                                     | 1102.9180 (272)            |        |        |        |        |        |                  |
| EPC Target Carbon Dioxide Emission Rate (TER)                                                        |                    |                                     | 11.1400 (273)              |        |        |        |        |        |                  |
| -----                                                                                                |                    |                                     |                            |        |        |        |        |        |                  |
| 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                                                                        | 3129.7674          | 1.1300                              | 3536.6371 (275)            |        |        |        |        |        |                  |
| Total CO2 associated with community systems                                                          |                    |                                     | 0.0000 (473)               |        |        |        |        |        |                  |
| Water heating (other fuel)                                                                           | 2983.8998          | 1.1300                              | 3371.8068 (278)            |        |        |        |        |        |                  |
| Space and water heating                                                                              |                    |                                     | 6908.4439 (279)            |        |        |        |        |        |                  |
| Pumps, fans and electric keep-hot                                                                    | 86.0000            | 1.5128                              | 130.1008 (281)             |        |        |        |        |        |                  |
| Energy for lighting                                                                                  | 215.7548           | 1.5338                              | 330.9319 (282)             |        |        |        |        |        |                  |
| Energy saving/generation technologies                                                                |                    |                                     |                            |        |        |        |        |        |                  |
| PV Unit electricity used in dwelling                                                                 | -778.2568          | 1.4959                              | -1164.1789                 |        |        |        |        |        |                  |
| PV Unit electricity exported                                                                         | -951.7059          | 0.4613                              | -438.9877                  |        |        |        |        |        |                  |
| Total                                                                                                |                    |                                     | -1603.1665 (283)           |        |        |        |        |        |                  |
| Total Primary energy kWh/year                                                                        |                    |                                     | 5766.3101 (286)            |        |        |        |        |        |                  |
| Target Primary Energy Rate (TPER)                                                                    |                    |                                     | 58.2500 (287)              |        |        |        |        |        |                  |