SYNTEGRA CONSULTING

# Energy and Sustainability Statement

15-1601

28 Redington Road, Hampstead, NW3 7RB

August 2016

**Quality Standards Control**

The signatories below verify that this document has been prepared in accordance with our quality control requirements. These procedures do not affect the content and views expressed by the originator.

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| *Revision* | *Rev A* | *Rev B* | *Rev C* |
|---|---|---|---|
| Date | 15/04/2016 | 18/05/2016 | 19/08/2016 |
| Prepared by | A. Fuentes | S. Lee | S. Lee |
| Checked by | U.Uzair | E. Jolly | A. Thorne |
| Authorised by | A.King | A.King | E. Jolly |

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# 1. Executive Summary

The design of the proposed development, **28 Redington Road, Hampstead, London**, will be comprised a new construction of 8 no. of residential units. The design has incorporated building fabric enhancement (above current building regulations requirements) to increase the energy efficiency of the building. This includes that the development uses less energy, by adopting sustainable design and construction measures and by supplying energy efficiently.

Given the complexity of calculating and assessing $CO_2$ emissions, **the London Borough of Camden** requires all proposed developments to incorporate sustainable design and construction measures by expecting **the new developments to achieve an overall 35% reduction of $CO_2$ emissions over the Part L2013 with 20% reduction of $CO_2$ emissions via onsite renewables,** in accordance with London Plan and Local Policies.

To meet the Local policy requirements, the development incorporates various sustainable design and construction measures including energy/ carbon reduction, water consumption, material procurement, and waste management. The recommendation for the energy/ carbon reduction is **to enhance fabric elements (U-values) as per Building Regulations Part L1A; to install communal air source heat pumps (minimum 350% efficiency for heating, 270% for cooling) for space heating, cooling and domestic hot water; to install low energy lights.** This results in followings:

1. The strategy would provide an average of **53% $CO_2$ reduction savings against the TER set by Building Regulation Part L1A.** Therefore, the strategy meets requirements of Building Regulations L1A 2013, the London Plan, and Local Policies.

2. The following hierarchy of the strategy has been explored and implemented:
   - BE LEAN: Energy efficient design
   - BE CLEAN: Connection to district heat networks or communal heating systems (e.g. Combined Heat and Power)
   - BE GREEN: Installation of on-site renewable energy technologies

3. The strategy at **BE GREEN stage** would provide an average **29% reduction of $CO_2$ emissions via onsite renewable technology (communal air source heat pumps)** for the overall development. This reduction is calculated after comparing with a communal gas boiler system with 95% efficiency.

4. Although the policy encourages that new residential developments meet the Code for Sustainable Homes (CSH) Level 6, the CSH has been withdrawn by the Government as of April 2015. As such a pre-assessment has not been provided as part of this strategy.

After the application of the proposed strategy, the regulated carbon dioxide emissions are presented on the table below:

| Energy Hierarchy | | Regulated Carbon Emissions (Tonnes $CO_2$/yr) |
|---|---|---|
| **BASELINE** | TER set by Building Regulations 2013 Part L | 32.42 |
| **BE LEAN** | After energy demand reduction | 21.44 |
| **BE CLEAN** | After CHP/ Communal Heating | 21.44 |
| **BE GREEN** | After renewable energy | 15.17 |

Table 1 Carbon Emissions after each stage of the proposed strategy

This carbon savings from each stage can be calculated based on the results above. The chart below summarises the total cumulative savings:

| Energy Hierarchy | | Regulated Carbon Savings | |
|---|---|---|---|
| | | Tonnes $CO_2$/yr. | % |
| **BE LEAN** | After energy demand reduction | 10.98 | 33.88 % |
| **BE CLEAN** | After heat network/ CHP | - | - |
| **BE GREEN** | After renewable energy | 6.27 | 29.23 % |
| **Total Cumulative Savings** | | **17.25** | **53.21%** |
| **Total Target Savings** | | 11.35 | 35 % |

Table 2 Carbon dioxide Emissions after each stage of the Energy Hierarchy

In summary, the strategy demonstrates a ***53%*** $CO_2$ reduction against the baseline (TER) through energy efficient design and onsite renewables. **The full SAP worksheets per each of the energy hierarchy are attached in Appendix B.**

## 2. Introduction

Syntegra Consulting Ltd has been appointed as sustainability consultants to produce an energy strategy for the **new construction of 6 storey building comprising of 8 no. of residential units** located in **Hampstead, Camden Borough** – to support the scheme design process, demonstrate Building regulations Part L1A 2013 compliance and intent to target a 20% reduction of $CO_2$ emissions reduction via onsite renewable energy technology for the overall development in accordance with the planning policy requirements.

This report will outline the following:

1) This report will assess the proposed development site's estimated energy demand & $CO_2$ emissions. It will look into the feasibility of Low Zero Carbon technologies, examining the following aspects relative to LZC/renewable technologies:

- Energy generated by Renewable/Low Zero Carbon Technologies (LZC)
- Feasibility assessment for each Renewable/Low Zero Carbon Technologies (LZC)
- Local Planning Requirements
- Life cycle Costs & payback period for the technology investment
- Available Grants

2) The proposed building fabric and Low Zero Carbon (LZC) design strategy and analysis calculations, with respect to the Standard Assessment energy assessment Procedure (SAP). Demonstration of how the design is compliant against the current Part L 2013 building regulations i.e. **the 35% reduction in $CO_2$ emissions** in accordance with the local planning policy.

3) The target of **a 20% reduction of the development's $CO_2$ Emissions** through the utilisation of renewable technology as per the planning policy requirements

4) Assessment of opportunities for utilising Decentralised Energy Networks and Combined Heat and Power (CHP) as per the planning policy requirements.

## 3. Site Description

The proposed development will be comprised of the **new construction of 6 storey building with a total of 8 no. of residential units** located in **Hampstead, Camden Borough**. The development is located in the area of Hampstead, North London and it is in close proximity to West Hampstead station (approximately 0.8 miles), Hampstead Underground Station (approx. 0.5 miles). The site is within the London Borough of Camden.

## 4. Planning Policy

### 4.1. National Planning Policy Framework (March 2012)

The National Planning Policy Framework is a key part of our reforms to make the planning system less complex and more accessible, to protect the environment and to promote sustainable growth.

### 4.2. The London Plan Renewable Energy Policy 2011 (Policy 5.2, 5.6 & 5.7)

The Mayor and boroughs should in their DPDs adopt a presumption that developments will achieve a reduction in carbon dioxide emissions of 20% from onsite renewable energy generation according to 5.42 section of Policy 5.7 Renewable Energy (which can include sources of decentralised renewable energy). According to Policy 5.2 (clause B) all residential and non-residential buildings should show an improvement of 40% BER/TER from 2013 to 2016, unless it can be demonstrated that such provision is not feasible. Furthermore, intent must be shown for connecting to a Decentralised Energy Network according to Policy 5.6 and utilizing a Combined Heat & Power.

### 4.3. London Borough of Camden

Camden

<u>**Camden Development Policies 2010-2025**</u>

**Policy DP22: Promoting Sustainable Design and Construction**

The Council will require development to incorporate sustainable design and construction measures. Schemes must:

a. demonstrate how sustainable development principles, have been incorporated into the design and proposed implementation; and
b. incorporate green or brown roofs and green walls wherever suitable.

The Council will promote and measure sustainable design and construction by:

c. expecting new build housing to meet Code for Sustainable Homes Level 3 by 2010 and Code Level 4 by 2013 and **encouraging Code Level 6 (zero carbon) by 2016.**;
d. expecting developments (except new build) of 500sqm of residential floor space or above or 5 or more dwellings to achieve 'very good' in EcoHomes assessments prior to 2013 and encouraging 'excellent' from 2013;
e. expecting non-domestic developments of 500sqm of floor space or above to achieve 'very good' in BREEAM assessments and 'excellent' from 2016 and encouraging zero carbon from 2019.

The Council will require development to be resilient to climate change by ensuring schemes include appropriate climate change adaptation measures, such as:

f. summer shading and planting;
g. limiting run-off;
h. reducing water consumption;
i. reducing air pollution; and
j. not locating vulnerable uses in basements in flood-prone areas.

**Policy DP23: Water**

The Council will require developments to reduce their water consumption, the pressure on the combined sewer network and the risk of flooding by:

a) incorporating water efficient features and equipment and capturing, retaining and re-using surface water and grey water on-site;
b) limiting the amount and rate of run-off and waste water entering the combined storm water and sewer network through the methods outlined in part a) and other sustainable urban drainage methods to reduce the risk of flooding;
c) reducing the pressure placed on the combined storm water and sewer network from foul water and surface water run-off and ensuring developments in the areas identified by the North London Strategic Flood Risk Assessment and shown on Map 2 as being at risk of surface water flooding are designed to cope with the potential flooding;
d) ensuring that developments are assessed for upstream and downstream groundwater flood risks in areas where historic underground streams are known to have been present; and
e) encouraging the provision of attractive and efficient water features.

**<u>Camden Core Strategy 2010-2025</u>**

**Policy CS13 – Tackling climate change through promoting higher environmental standards**

**Reducing the effects of and adapting to climate change**

The Council will require all development to take measures to minimise the effects of, and adapt to, climate change and encourage all development to meet the highest feasible environmental standards that are financially viable during construction and occupation by:

a. ensuring patterns of land use that minimise the need to travel by car and help support local energy networks;

b. promoting the efficient use of land and buildings;
c. minimising carbon emissions from there development, construction and occupation of buildings by implementing, in order, all of the elements of the following energy hierarchy:
   1. ensuring developments use less energy,
   2. making use of energy from efficient sources, such as the King's Cross, Gower Street, Bloomsbury and proposed Euston Road decentralized energy networks;
   3. generating renewable energy on-site;
   and
d. ensuring buildings and spaces are designed to cope with, and minimise the effects of, climate change.

The Council will have regard to the cost of installing measures to tackle climate change as well as the cumulative future costs of delaying reductions in carbon dioxide emissions

**Local energy generation**

The Council will promote local energy generation and networks by:

e. working with our partners and developers to implement local energy networks in the parts of Camden most likely to support them, i.e. in the vicinity of
   - housing estates with community heating or the potential for community heating and other uses with large heating loads;
   - the growth areas of King's Cross; Euston; Tottenham Court Road; West Hampstead Interchange and Holborn;
   - schools to be redeveloped as part of Building Schools for the Future programme;
   - existing or approved combined heat and power/local energy networks (see Map4);

and other locations where land ownership would facilitate their implementation.

f. protecting existing local energy networks where possible (e.g. at Gower Street and Bloomsbury) and safeguarding potential network routes (e.g. Euston Road);

**Water and surface water flooding**

We will make Camden a water efficient borough and minimise the potential for surface water flooding by:

g. protecting our existing drinking water and foul water infrastructure, including Barrow Hill Reservoir, Hampstead Heath Reservoir, Highgate Reservoir and Kidderpore Reservoir;
h. making sure development incorporates efficient water and foul water infrastructure;
i. requiring development to avoid harm to the water environment, water quality or drainage systems and prevents or mitigates local surface water and downstream flooding, especially in areas up-hill from, and in, areas known to be at risk from surface water flooding such as South and West Hampstead, Gospel Oak and King's Cross (see Map 5).

**Camden's carbon reduction measures**

The Council will take a lead in tackling climate change by:

j. taking measures to reduce its own carbon emissions;
k. trialling new energy efficient technologies, where feasible; and
l. raising awareness on mitigation and adaptation measures.

**Generating renewable energy on-site**

13.11 Buildings can also generate energy, for example, by using photovoltaic panels to produce electricity, or solar thermal panels, which produce hot water. Once a building and its services have been designed to make sure energy consumption will be as low as possible and the use of energy efficient sources has been considered, **the Council will expect developments to achieve a reduction in carbon dioxide emissions of 20% from on-site renewable energy generation** (which can include sources of site-related decentralised renewable energy) unless it can be demonstrated that such provision is not feasible. Details on ways to generate renewable energy can be found in our Camden Planning Guidance supplementary document.

# 5. Sustainable Design and Construction

## 5.1. Bicycle Storage

To promote exercise and help reduce congestion and carbon emissions, cyclist facilities are provided on the lower ground floor in line with the sustainable development principles in the Local Policy DP22. The facility includes bike storage and private lockers. As each residential unit has their own shower facilities, additional showers are not provided on the lower ground floor.

## 5.2. Water Efficiency

The development will be based upon the specification of water efficient fittings across the development including low volume dual flush WCs, low flow taps and showers in accordance with planning requirements - i.e. **the targeted water consumption is 105 l/p/day** plus an additional 5 litres for external water use.

**Since the proposed scheme is categorised as a minor development (8 dwelling units), rainwater/ grey water harvesting systems have not been considered at this early design stage. However, if required they would be considered in the course of design development where feasible.**

## 5.3. Waste

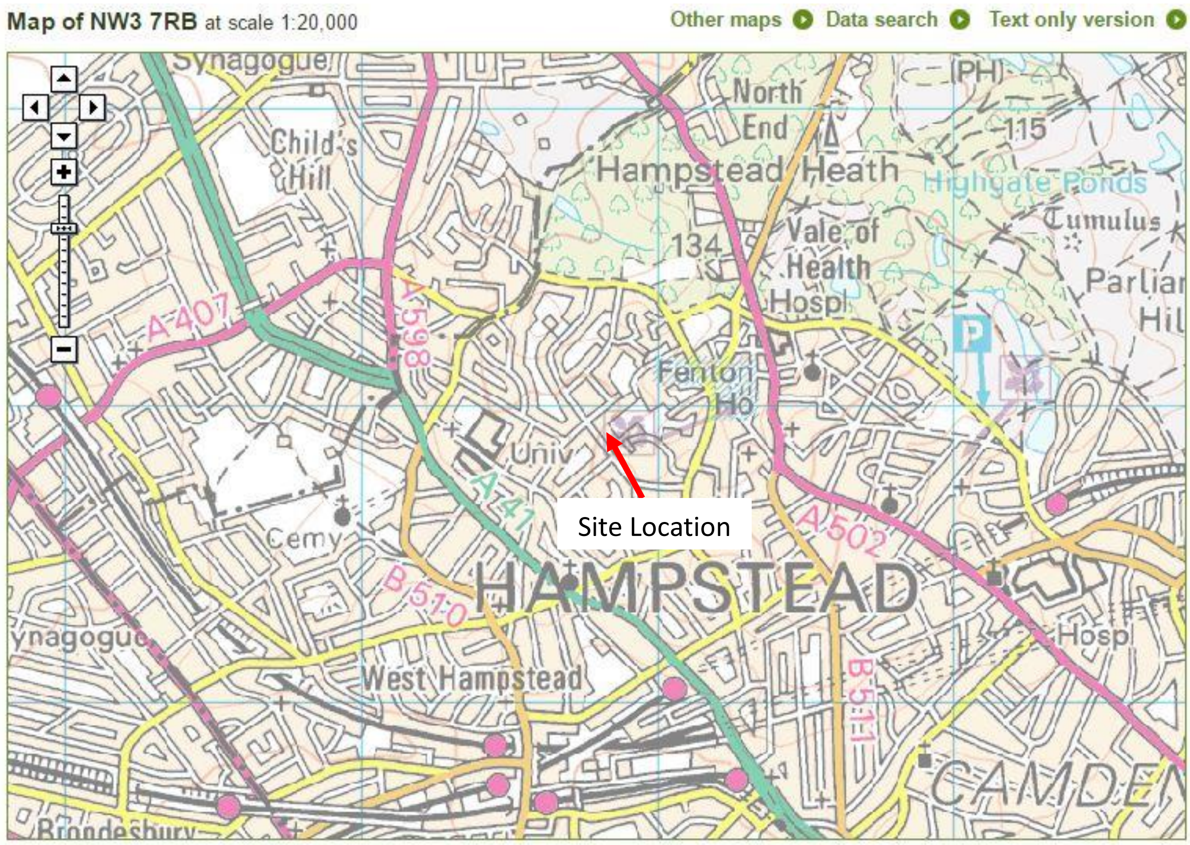
The proposed development will adopt the best waste management procedures to reduce the amount of waste going to landfill. This will be established by creating provisions for recycling and also waste segregation from general to recyclable waste. To enhance the waste reduction potential, the provision of kitchen and garden waste composting will be considered as a measure of reducing the amount of waste going to landfill in accordance with the council's recycling collection scheme. The construction waste should also be considered to minimise, recycle and reuse on site where possible, this will reduce the overall construction cost and at the same time minimise the amount of waste diverting to landfill. Site Waste Management Plan (SWMP) will be formalised before the construction works start and updated as the works continue on the site.

## 5.4. Materials

The development will aim to procure/ utilise European compliant construction material including Sustainable timber. All the other building materials will achieve 'A' or higher ratings against BRE Green guide rating where feasible. The materials will be responsibly and locally sourced from suppliers where feasible. In order to minimise the environmental impact of construction the existing building materials such as aggregates will be reused on site where possible. This is in line with Camden council's policy requirements for DP22.

## 5.5. Flood Risk

The Environmental Agency map shows that the site surrounding area is within zone 1 of the flood risk. However, the detail flood assessment on the site will be undertaken for the proposed scheme to identify anticipated level of flooding and recommendations will also be obtained to improve the flood levels. In order to protect the site for future climate change impacts the Sustainable drainage strategy (SUDS) has been developed to minimise the risk of flooding in accordance with the National Planning Policy Framework and Camden’s requirements.



# 6. Energy Assessment

## 6.1. The Energy Hierarchy

The Mayor's Energy Strategy adopts a set of principles to guide design development and decisions regarding energy, balanced with the need to optimise environmental and economic benefits. These guiding principles have been reordered since the publication of the Mayor's Energy Strategy in Feb 2004 and the adopted replacement London Plan 2011 states that 'The following hierarchy should be used to assess applications:

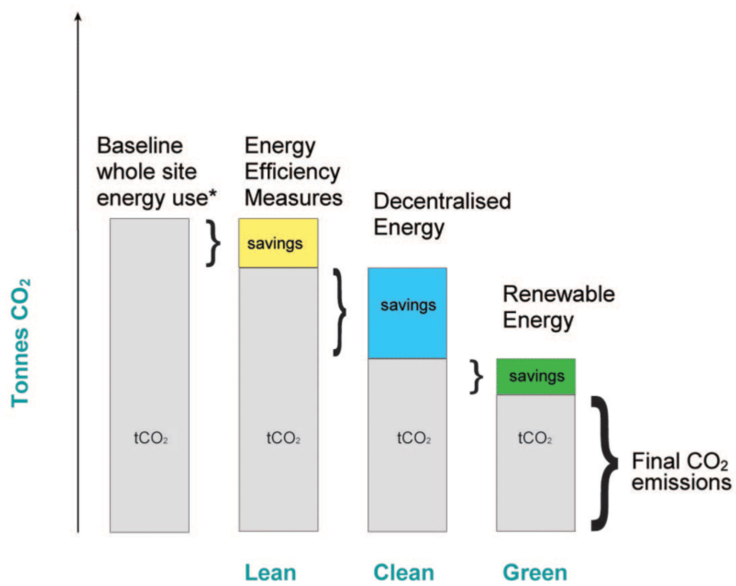
- *Using less energy, in particular by adopting sustainable design and construction measures;*
- *Supplying energy efficiency, in particular by prioritising decentralised energy generation; and*
- *Using renewable energy.*

The development's Energy Strategy has adopted the following design ethos:

✓ **BE LEAN** – By using less energy and taking into account the further energy efficiency measure in comparison to the baseline building.

✓ **BE CLEAN** – By supplying energy efficiently. The clean building looks at further carbon dioxide emission savings over the lean building by taking into consideration the use of decentralise energy via CHP.

✓ **BE GREEN** – By integrating renewable energy into the scheme which can further reduce the carbon dioxide emission rate.



## 6.2. Input data for energy assessment

Syntegra received the architectural drawings in AutoCAD format, and they were used to undertake the energy assessments i.e. SAP calculations. The drawing references are listed in table below.

| No. | Drawing Name | Format |
|---|---|---|
| 1 | JCA-RR-PR-001 Location Plan | .dwg |
| 2 | JCA-RR-PR-002 Site Plan | .dwg |
| 3 | JCA-RR-PR-003 Site Plan | .dwg |
| 4 | JCA-RR-PR-010 Lower ground Floor | .dwg |
| 5 | JCA-RR-PR-011 Ground Floor | .dwg |
| 6 | JCA-RR-PR-012 First Floor | .dwg |
| 7 | JCA-RR-PR-013 Second Floor | .dwg |
| 8 | JCA-RR-PR-014 Third Floor | .dwg |
| 9 | JCA-RR-PR-015 Third Floor | .dwg |
| 10 | JCA-RR-PR-015 Roof Plan | .dwg |

Table 3 The drawing list

The following table presents the type, area and number of units to be assessed within this report:

| NEW BUILD | | | | |
|---|---|---|---|---|
| **Type** | **Name of unit** | **Storey** | **No. of Bedrooms** | **Floor Area** ($m^2$) |
| **Residential** | 1 | 2-storey | 2 | 144 |
| | 2 | 1-storey | 3 | 224 |
| | 3 | 2-storey | 3 | 242 |
| | 4 | 1-storey | 2 | 178 |
| | 5 | 1-storey | 2 | 151 |
| | 6 | 1-storey | 2 | 167 |
| | 7 | 2-storey | 4 | 271 |
| | 8 | 2-storey | 2 | 166 |
| **TOTAL** | | | | **1,563** |

Table 4 Proposed units to be assessed for the development

The assessment has assumed the following fuel carbon emissions factors. The fuel carbon emissions factors used are in accordance with **SAP 2012 (for Building Regs Part L1A 2013).**

| Carbon Emissions Factor | SAP 2013 kgCO2/kW |
|---|---|
| Natural Gas | 0.216 |
| LPG | 0.241 |
| Biogas | 0.098 |
| Heating Oil | 0.298 |
| Coal (traditional British Coal) | 0.394 |
| Anthracite | 0.394 |
| Smokeless fuel | 0.433 |
| Dual Fuel (mineral + wood) | 0.226 |
| Biomass | 0.123 |
| Grid Electricity | 0.519 |
| Waste Heat | 0.058 |

Table 5. Carbon emission factors

## 6.3. BASELINE

The baseline energy use and resulting $CO_2$ emissions rates of the development have been assessed using the SAP 2012 Government approved software. The SAP 2012 calculations have been produced according to the ADL1A 2013 building regulation requirements.

For the purpose of this report the baseline energy use and $CO_2$ emissions for the development are calculated based on the minimum requirements as per the Building Regulations AD L1A (Table below).

| | | Part L1A 2013 min. required values |
|---|---|---|
| **U-value** ($W/m^2$ K) | Wall | 0.30 |
| | Window | 2.00 |
| | Floor | 0.25 |
| | Roof | 0.20 |
| **Air Permeability** ($m^3/h.m^2$ at 50 Pa) | | 10 |

Table 6 Required values set by Building Regulations Part L1A 2013

The baseline average energy use and $CO_2$ emissions for the development are presented in the tables below:

| BASELINE: TER | Regulated $CO_2$ Emissions (Tonnes $CO_2$/yr) |
|---|---|
| Flat 1 | 3.52 |
| Flat 2 | 4.30 |
| Flat 3 | 4.31 |
| Flat 4 | 3.41 |
| Flat 5 | 3.44 |
| Flat 6 | 3.70 |
| Flat 7 | 5.48 |
| Flat 8 | 4.26 |
| **TOTAL** | **32.42** |

Table 7 Regulated Carbon Emissions at Baseline

### 6.4. BE LEAN – Energy Efficient Design

This section outlines the design energy efficient measures taken in order to minimise the building's energy demand and therefore reduce energy use and $CO_2$ emissions further than the Baseline (Building Regulations 2013 Part L compliance).

The energy efficient measures include:

1. Inclusion of better U-values than the minimum U-values set in the ADL1A 2013 document.
2. Designing for a buildings air permeability exceeding ADL1A 2013 target values.
3. Utilising the highly efficient heating and hot water systems.
4. Utilising low energy efficient lighting such as LED lighting.

**Efficient Building elements**

At the 'BE LEAN' stage of the energy hierarchy, energy efficient building elements have been incorporated into the build. Please see below more specifically:

| | | Part L1A 2013 min. required values | Proposed building values |
|---|---|---|---|
| **U-value** (W/m$^2$ K) | Wall | 0.3 | 0.12 |
| | Window | 2 | 1.2 (Roof light 1.3) |
| | Floor | 0.25 | 0.12 |
| | Roof | 0.2 | 0.12 |
| **Air Permeability** (m$^3$/h.m$^2$ at 50 Pa) | | 10 | 4.5 |

Table 8 Proposed Building Elements

**Heating, Cooling and Hot Water**

At the 'BE LEAN' stage, communal gas boilers have been examined for space heating and hot water in accordance with GLA Guidance on preparing energy assessment (March 2016). Detailed specifications that have been used at BE LEAN stage are in the table below.

**Please note that above systems have been used only for carbon emissions calculation at BE LEAN stage as per GLA Guidance on energy assessment. Suggested systems for this development will be mentioned at BE GREEN stage as renewable technology (ASHPs) has been suggested – Section 6.6.**

| Systems | General Specification | Controls/ Other inputs |
|---|---|---|
| **Heating** | Heat Efficiency of 95% | • Charing system linked to use of community heating, programmer and at least two room thermostat<br>• Heating Emitter – Underfloor heating |
| **Cooling** | Split/ multiple systems (EER of 2.7) | • On/ Off control |
| **Hot water** | From main heating system | • Plate heat exchanger of 1 litre<br>• Jacket insulation of 50mm<br>• Fully insulated primary pipework<br>• Cylinderstat<br>• Water Heating Timed Seperately |

Table 9 Be Lean Stage Heating and Hot water systems

## Ventilation

A natural supply ventilation strategy will be adopted with extract fans in bathrooms and kitchen. Therefore, higher energy consumption and $CO_2$ emissions due to mechanical ventilation is avoided.

## Lighting

The proposed light fittings will be low energy efficient fittings; these can be T5 fluorescent fittings with high frequency ballasts, or LED fittings.

The following tables demonstrate the reduction in $CO_2$ emissions from the energy efficiency measures mentioned above. It can be seen that the overall $CO_2$ reduction at Be Lean stage is ***33%*** for the total emissions.

## BE LEAN STAGE

| | **Regulated $CO_2$ Emissions** (Tonnes $CO_2$/yr) | |
|---|---|---|
| | **BASELINE** | **BE LEAN** |
| Flat 1 | 3.52 | 2.31 |
| Flat 2 | 4.30 | 2.83 |
| Flat 3 | 4.31 | 2.68 |
| Flat 4 | 3.41 | 2.12 |
| Flat 5 | 3.44 | 2.28 |
| Flat 6 | 3.70 | 2.47 |
| Flat 7 | 5.48 | 3.78 |
| Flat 8 | 4.26 | 2.97 |
| **TOTAL** | **32.42** | **21.44** |
| **Carbon Reduction** | **-** | **33.88 %** |

Table 10 Regulated Carbon Emissions at Be Lean Stage

## 6.5. BE CLEAN – CHP & Decentralised Energy Networks

The Energy Hierarchy encourages the use of a CHP system and the connection to District Heating system to reduce $CO_2$ emissions further.

**CHP**

The Energy Hierarchy identifies the combined heat and power (CHP) as a method of producing heat and electricity with much lower emissions than separate heat and power. Also, it encourages the creation of district heating systems supplied by CHP.
The implementation of a CHP strategy should be decided according to good practice design. Key factors for the efficient implementation of the CHP system are:

- Development with high heating load for the majority of the year.
- CHP operation based on maximum heat load for minimum 10 hours per day.
- CHP operation at maximum capacity of 90% of its operating period.

To ensure that CHP is financially viable it is essential that the unit is selected to meet the base heat load and that this load is maintained over a large proportion of the day (a figure of 14 – 17 hours per day is often quoted subject to the load profiles and gas and electricity prices) to ensure that the additional costs (maintenance) associated with running a CHP unit can be recovered.

This need to run the CHP plant, as far as possible continuously makes the building load profile of prime importance when reviewing the viability of such solutions and in particular the summer time heat load profile. CHP systems only make financial sense to operate when the waste heat associated with generating the electricity is usefully used. To enable the CHP plant to run continuously when it is operating, a thermal store is often used so that excess CHP capacity can be used to generate hot water for use at a later time.

The load profile for this kind of development is intermittent. Hence a CHP system has not been considered for this development

**Micro-CHP**

Micro CHP has not been considered further for this project due to the following reasons:
Micro-CHP is a relatively new concept and issues are raised in relation to unproven technology, inefficiency for shorter run cycles and lack of technical knowledge that can limit the practical application of micro CHP at present. In addition, other issues surrounding the fact that around 50% of electricity generated in domestic properties is surplus, high installation costs and estimated low life expectancy has also been taken into consideration as to its Commercial unit's un-viability for this development scheme. Micro-CHP also has lower FIT tariff rate and period duration and is only applicable for systems under 2kW.

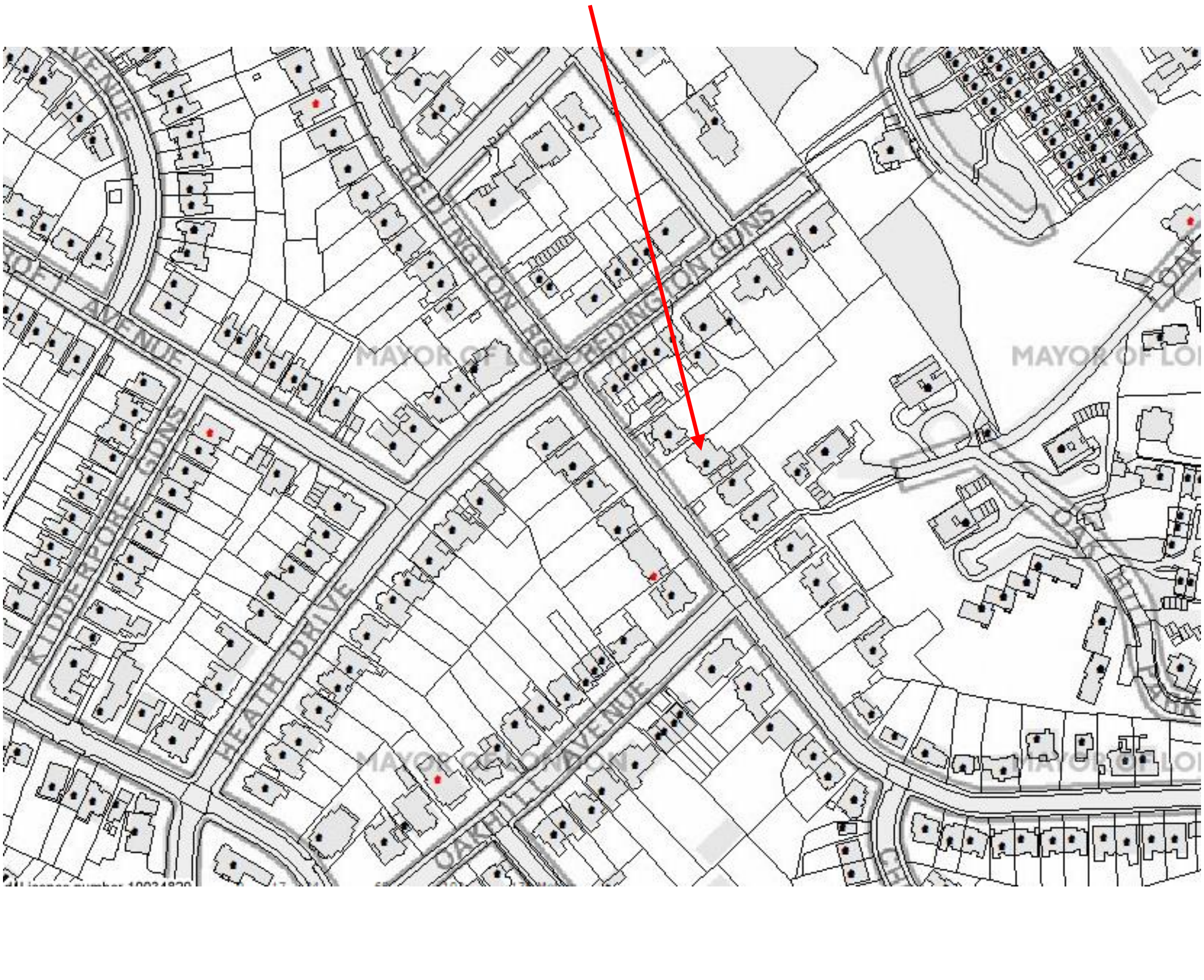
## Decentralised Energy Network

The Mayor's Energy Strategy favours community heating systems because they offer:

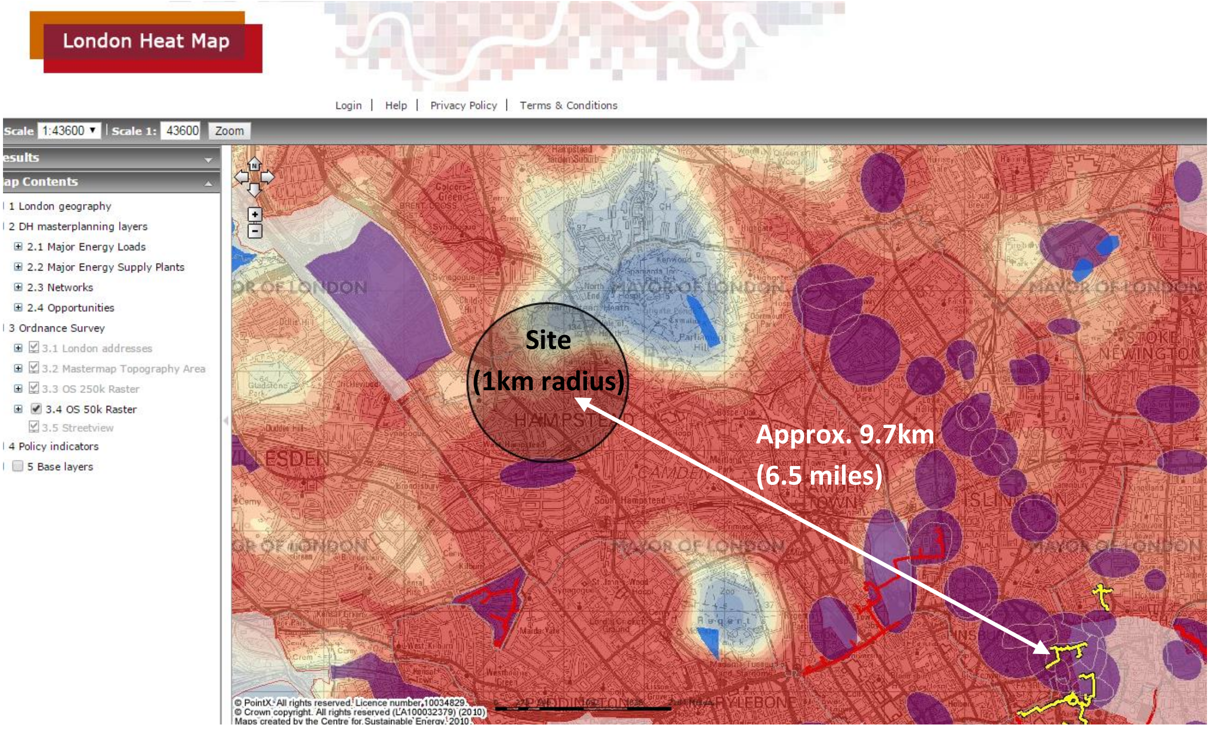
- ✓ Potential economies of scale in respect of efficiency and therefore reduced carbon emissions; and
- ✓ Greater potential for future replacement with Low or Zero Carbon (LZC) technologies.

The feasibility of connecting into an existing heating network or providing the building with its own combined heat and power plant has been assessed alongside the **London Heat Map Study for the London Borough of Camden** as part of this assessment. The study identifies that the site is not located near the existing or potential district heating networks. This is demonstrated clearly from the London Heat Map (http://www.londonheatmap.org.uk) snapshot below.

Site Location



Moreover, the London heat map below identifies existing DH networks in more broaden area, and it could not find any existing DH networks (in yellow) within 1km radius from the property. The costs involved in extending the existing DH network would outweigh the advantages in this development. **Therefore, utilisation of the DH network has not been a feasible option for this development.**




## BE CLEAN STAGE

## 6.6. BE GREEN – Renewable Energy

In this section the viable renewable energy technologies that will reduce the development's $CO_2$ emissions further by 20% are examined. Incorporating lean design measures will significantly reduce the onsite energy consumption and the $CO_2$ emissions of the building however the reduction in emissions is still short of the target set out in the 'London Plan'. The 'London Plan' also states that a 20% $CO_2$ reduction must be achieved by the installation of renewable technologies. Below is a review of possible renewable technologies for incorporation in the proposed development.

All of the LZC technologies are assessed against a number of criteria. Hence, LZC technology feasibility will be assessed according to the following criteria:

- ✓ Renewable energy resource or fuel availability of the LZC technology on the site.
- ✓ Space limitations due to building design and urban location of the site.
- ✓ Capital, operating and maintenance cost.
- ✓ Planning Permission
- ✓ Implementation with regards the overall M&E design strategy for building type
- ✓ Available Grants [See Appendix Section 8.9]

The renewable/LZC technologies which were found non feasible based on the above criteria are the following:

- PV panels [See Appendix Section 8.1]
- Solar Thermal [See Appendix Section 8.2]
- Wind Turbines [See Appendix Section 8.3]
- Small scale hydro power [See Appendix Section 8.4]
- Biomass Heating [See Appendix Section 8.5]
- Ground Source Heat Pump (GSHP) [See Appendix Section 8.6]
- CHP & Micro CHP [See Appendix Section 8.7]
- Hydrogen Fuel Cells [See Appendix Section 8.8]

**Air Source Heat Pump (ASHP) – Proposed Technology**

ASHP can meet the space heating demands on site efficiently in comparison with gas boilers. Although this low carbon technology consumes electricity to operate due to higher efficiency the heat output is much greater. Therefore, it has been suggested for the space heating, cooling and hot water. The specification of these are in the table below. **Emergency immersion heaters in the energy store can be used as a back-up system. And, the energy storage tanks will be used to account for fluctuations in load. Hence, this system can provide consistent space heating and hot water all year around.**

| Systems | General Specification | Controls/ Other inputs |
|---|---|---|
| **Heating** | Heat Efficiency of 350% | • Charing system linked to use of community heating, programmer and at least two room thermostat<br>• Heating Emitter – Underfloor heating |
| **Cooling** | EER of 2.7 | • Split/multiple systems<br>• On/Off control |
| **Hot Water** | From main heating system | • Plate heat exchanger of 1 litre<br>• Jacket insulation of 50mm<br>• Fully insulated primary pipework<br>• Cylinderstat<br>• Water Heating Timed Seperately |

Table 11 Be Green Stage Heating and Hot water systems

All suggested specifications above are provisional at this early design stage, and therefore have to be reviewed with mechanical engineers and contractors in the course of design development.

Tariffs that apply for domestic Renewable Heat Incentive (RHI) is as shown in the table below based on the following link. https://www.ofgem.gov.uk/environmental-programmes/domestic-rhi/contacts-guidance-and-resources/tariffs-and-payments-domestic-rhi/current-future-tariffs.

| Type | Technology | RHI | Eligibility |
|---|---|---|---|
| Domestic | Air source heat pumps | 7.51 in pence per kWh | Application submitted between 01/04 2016 – 30/09/2016 |

Table 12 Current tariffs for Renewable Heat Incentive (RHI)

To check the compliance with target reduction (20%) via onsite renewables, the communal ASHP system has been compared with the communal gas boiler as mentioned at BE LEAN stage. The table below confirms that the communal ASHP system can achieve the ***29%*** carbon reduction against the communal gas system.

## BE GREEN stage

| | **Regulated $CO_2$ Emissions** (Tonnes $CO_2$/yr) | |
|---|---|---|
| | **BE LEAN** | **BE GREEN** |
| Flat 1 | 2.31 | 1.63 |
| Flat 2 | 2.83 | 2.01 |
| Flat 3 | 2.68 | 1.94 |
| Flat 4 | 2.12 | 1.53 |
| Flat 5 | 2.28 | 1.61 |
| Flat 6 | 2.47 | 1.74 |
| Flat 7 | 3.78 | 2.64 |
| Flat 8 | 2.97 | 2.07 |
| **TOTAL** | **21.44** | **1.52** |
| **Carbon Reduction** | **-** | **29.23 %** |

Table 13 Regulated Carbon Emissions at Be Lean Stage

## 7. Conclusion

The design of the proposed development, **28 Redington Road, Hampstead, London**, will be comprised a new construction of 8 no. of residential units. To meet the Local policy requirements, the development incorporates various sustainable design and construction measures including energy/ carbon reduction, water consumption, material procurement, and waste management. The recommendation for the energy/ carbon reduction is **to enhance fabric elements (U-values) as per Building Regulations Part L1A; to install communal air source heat pumps (minimum 350% efficiency for heating, 270% for cooling) for space heating, cooling and domestic hot water; to install low energy lights.** This results in followings:

1. The strategy would provide an average of **53% $CO_2$ reduction savings against the TER set by Building Regulation Part L1A.** Therefore, the strategy meets requirements of Building Regulations L1A 2013, the London Plan, and Local Policies.

2. The strategy at **BE GREEN stage** would provide an average **29% reduction of $CO_2$ emissions via onsite renewable technology (communal air source heat pumps)** for the overall development. This reduction is calculated after comparing with a communal gas boiler system with 95% efficiency.

The carbon savings from each stage can be calculated based on the results above. The chart below summarises the total cumulative savings:

| Energy Hierarchy | | Regulated Carbon Savings | |
|---|---|---|---|
| | | Tonnes $CO_2$/yr. | % |
| **BE LEAN** | After energy demand reduction | 10.98 | 33.88 % |
| **BE CLEAN** | After heat network/ CHP | - | - |
| **BE GREEN** | After renewable energy | 6.27 | 29.23 % |
| **Total Cumulative Savings** | | **17.25** | **53.21%** |
| **Total Target Savings** | | 11.35 | 35 % |

Table 14 Carbon dioxide Emissions after each stage of the Energy Hierarchy

In summary, the strategy demonstrates a ***53%*** $CO_2$ reduction against the baseline (TER) through energy efficient design and onsite renewables, and therefore the proposed scheme meets the planning requirement of a 35% reduction.

# 8. Appendix A – Low & Zero Carbon Energy Systems

## 8.1. Photovoltaic Systems

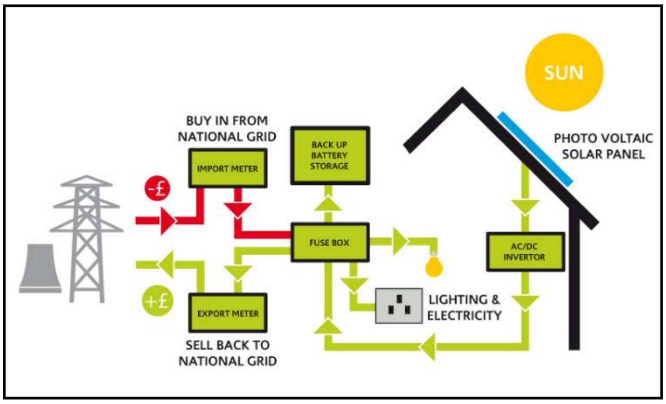
**Description of PV Systems**

Photovoltaic systems convert energy from the sun directly into electricity. They are composed of photovoltaic cells, usually a thin wafer or strip of semiconductor material that generates a small current when sunlight strikes them. Multiple cells can be assembled into modules that can be wired in an array of any size. These flat-plate PV arrays can be mounted at a fixed angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture the most sunlight over the course of a day, or even in the form of a solar PV facade. Several connected PV arrays can provide enough power for a household/building.
Thin film solar cells use layers of semiconductor materials only a few micrometers thick. Thin film technology has made it possible for solar cells to now double as rooftop shingles, roof tiles, building facades, or the glazing for skylights or atria. The solar cell version of items such as shingles offer the same protection and durability as ordinary asphalt shingles.

**Advantages**

The PV systems are relatively simple, modular, and highly reliable due to the lack of moving parts. Moreover, PV systems do not produce any greenhouse gases, on the contrary they save approximately 325kg of $CO_2$ per year kWp they generate.

**Best Practice Design**




PV installations performance is proportional to the active area (area covered by PVs). The desirable location for PV panels is on a south facing roof or façade, as long as no other building or tall trees overshadows it, resulting in reduced PV efficiency. PV panels are required strong structurally roofs due to their heavy weight, especially if the panels are placed on top of existing tiles. The area of PV panels required to generate 1 kWp varies but generally 6-8m$^2$ for mono-crystalline and 10m$^2$ for polycrystalline panels will generate 1kWp (kWp-energy generated at full sunlight) of electricity.

**Cost & Maintenance**

Prices for PV systems vary, depending on the size of the system to be installed, type of PV cell used and the nature of the actual building on which the PV is mounted. The size of a PV system depends on the buildings electricity demand. Solar tiles cost more than conventional panels, and panels that are integrated into a roof are more expensive than those that sit on top. Grid connected systems require very little maintenance, generally limited to ensuring that the panels are kept relatively clean and that shade from trees does not obstruct the sunlight path. However, the wiring and system components should be checked regularly by a qualified technician.

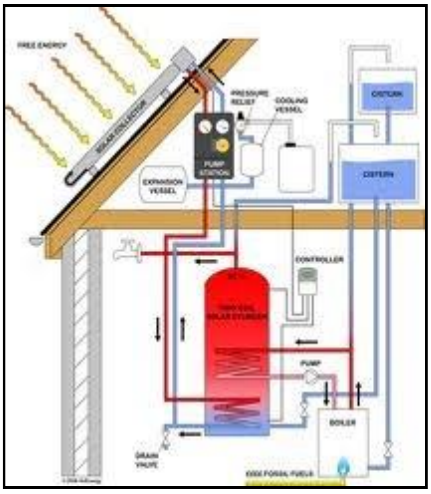
**Feasibility on the site**

The property falls within sub-area four 'Redington Road and Templewood Avenue' of the conservation area, and Policy DP25 seeks the retention of the appearance of the conservation area. Therefore, installing PV panels on the roof would harm keeping the character of the conservation area, and discussion with the planning authority is required in advance. Moreover, the roof space is not sufficient to meet a 35% carbon reduction. In this circumstances, PV panels is not a suitable technology for this development.

## 8.2. Solar Thermal Systems

Solar systems can be used wherever moderately hot water is required. Off-the-shelf packages provide hot water to the bathroom and kitchen of a house; custom systems are designed for bigger loads, such as multi-unit apartments.

The most common collector is called a flat-plate collector. Mounted on the roof, it consists of a thin, flat, rectangular box with a transparent cover that faces the sun. Small tubes run through the box and carry the fluid – either water or other fluid, such as an antifreeze solution – to be heated. The tubes are attached to an absorber plate, which is painted black to absorb the heat. As heat builds up in the collector, it heats the fluid passing through the tubes.




**Cost & Maintenance**

Evacuated tube systems are more expensive due to their higher manufacturing cost.

SWH systems in general have a 5-10 years warranty and require little maintenance. A yearly check by the owner of the system and a more detailed maintenance check by a qualified installer every 3-5 years should be adequate.

**Feasibility on the site**

As mentioned in the previous section, the property falls within the conservation area, and therefore installing solar thermal systems on the roof would harm keeping the character of the conservation area. Moreover, the use of solar thermal for this development would be limited to domestic hot water only. The use of solar thermal for space heating would not be practical as it is not required when solar thermal is at its most effective during the summer months. Therefore, this system would require additional plumbing and space for hot water storage, incurring additional financial cost. Hence, this technology is deemed to be unsuitable for this development.

### 8.3. Wind Turbines

**Description of Wind Turbine**

Wind energy systems convert the kinetic energy of moving air into electricity or mechanical power. They can be used to provide power to central grids or isolated grids, or to serve as a remote power supply or for water pumping. Wind turbines are commercial units available in a vast range of sizes. The turbines used to charge batteries and pump water off-grid tend to be small, ranging from as small as 50 W up to 10 kW. For isolated grid applications, the turbines are typically larger, ranging from about 10 to 200 kW. Wind turbines are mounted on a tower to harness the most energy. At 30 meters or more aboveground, they can capture the faster and less turbulent wind in an urban environment. Turbines harness the wind's energy with their propeller-like blades. In most of the cases, two or three blades are mounted on a shaft to form a rotor.
There are two types of wind turbines that can be used for buildings:

- Mast mounted – which are free standing and located near the building that will be consuming the generated electricity.
- Roof Mounted – which can be installed on house roofs and other buildings.

**Planning Issues**

Planning issues such as visual impact, noise and conservation issues also have to be considered. System installation normally requires permission from the local authority.

**Cost & Maintenance**

- Roof mounted turbines cost from £3000. The amount of energy and carbon that roof top micro wind turbines save depends on size, location, wind speed, nearby buildings and the local landscape. At the moment there is not enough data from existing wind turbine installations to provide a figure of how much energy and $CO_2$ could typically be saved. The Energy saving trust is monitoring up to 100 installations nationwide which will give ball park figures of carbon savings.
- Mast Mounted turbines in the region of 2.5kW to 6kW would cost approximately £11000-£19000. These costs are inclusive of the turbine, mast, inverters, battery storage and installation cost. It should be noted that these costs vary depending on location, size and type of system to be installed.
- Turbines have an operational lifetime of up to 22.5 years but require service checks every few years to ensure efficient operation. For battery storage systems, typical battery life is around 6-10 years, depending on the type, so batteries may have to be replaced at some point in the system's life.

**Feasibility on the site**

Wind turbines are not feasible for the development due to the insufficient wind speed. Since the development is located in a dense residential and commercial units area; the wind resource may be restricted due to the adjacent large trees and air turbulence generated between them. As shown below (http://tools.decc.gov.uk/en/windspeed/default.aspx), the yearly average wind speed at this site is quite low at 10 meters above ground.

Wind speed at 45m agl (in m/s)

| | | |
|---|---|---|
| 6 | 6 | 6 |
| 6 | 6 | 6 |
| 6 | 6 | 6 |

Wind speed at 25m agl (in m/s)

| | | |
|---|---|---|
| 5.5 | 5.5 | 5.5 |
| 5.5 | 5.5 | 5.5 |
| 5.5 | 5.5 | 5.5 |

Wind speed at 10m agl (in m/s)

| | | |
|---|---|---|
| 4.7 | 4.7 | 4.7 |
| 4.7 | 4.7 | 4.7 |
| 4.7 | 4.8 | 4.8 |

Blank squares indicate areas outside the land area of the UK - i.e. areas at sea or of neighbouring countries.
agl = above ground level.
Squares surrounding the central square correspond to wind speeds for surrounding grid squares.

An actual wind-speed measurement using an anemometer has not been used for the purpose of this energy strategy report.

Wind turbine(s) have been discounted for this development scheme for the following reasons:

- A large mast horizontal axis wind turbine will not be able to generate electricity at optimal operating range since it requires higher average wind speeds. Furthermore, the installation of small scale wind turbines won't be feasible due to low average wind speed at 10 meters height, 25m & 45metre heights.
- Due to the close proximity of neighbouring Commercial units & residential properties and trees.
- In addition, the low frequency noise generated by wind turbines might cause inconvenience to the neighbouring residents. However, the level a person can be affected by low frequency noise varies from individual to individual.

- Due to the size and the required height of a potential wind turbine scheme there is also an issue with the propellers' impacting bird traffic, obtrusiveness, shadow flicker which means that generally large wind turbines need to be located at least 300m from any residential properties, which would not be possible on this site.
- Roof mounted units are limited in size due to wind induced stresses which are transmitted to the building structure. Most roof mounted turbines currently on the market are approximately 2m diameter and capable of producing 1-1.5kW each. However, the output is dependent on the surrounding obstructions and local wind speed. Thus small scale wind turbines would not make any meaningful impact on a site such as this.
- There are likely to be planning issues associated with wind turbines of a size necessary to affect any significant CO2 savings or energy savings.
- Because of the above the investment case with regards this technology solution is not viable compared to other solutions with a more attractive ROI.
- Finally, the installation of wind turbines on the development requires planning permission (and is likely to instigate neighbourhood committee interest regarding its aesthetics and acoustic issues).

## 8.4. Small Scale Hydro

**Description of Small Scale Hydro System**

Small hydro systems convert the potential and kinetic energy of moving water into electricity, by using a turbine that drives a generator. As water moves from a higher to lower elevation, such as in rivers and waterfalls, it carries energy with it; this energy can be harnessed by small hydro systems. Used for over one hundred years, small hydro systems are a reliable and well-understood technology that can be used to provide power to a central grid, an isolated grid or an off-grid load, and may be either run-of-river systems or include a water storage reservoir.

In a residential small scale hydro system the constant flow of water is critical to the success of the project. The energy available from a hydro turbine is proportional to the flow rate of the water and the head height. Since the majority of the cost of a small hydro project stems from up front expenses in construction and equipment purchase, a hydro project can generate large quantities of electricity with very low operating costs and modest maintenance expenditures for 50 years or longer.

**Advantages**

For houses with no mains connection but with access to a micro hydro site, a good hydro system can generate a steady, more reliable electricity supply than other renewable technologies at lower cost. Total system costs can be high but often less than the cost of a grid connection and with no electricity bills to follow.

**Cost & Maintenance**

Small hydro schemes are very site specific and are related to energy output. For low heat systems, costs may lie in the region of £4,000 per kW installed up to about 10kW and would drop per kW for larger schemes.

For medium heads, there is a fixed cost of about £10,000 and about £2,500 per kW up to around 10kW

Unit costs drop for larger schemes. Maintenance costs vary but small scale hydro systems are very reliable.

**Feasibility on the site**

Small scale hydro-electric will not be studied any further because of the location and the spatial limitations of the development. There is no river or lake within the development site boundaries. As a result, this solution will not be assessed any further.

## 8.5. Biomass Heating

**Description of Biomass Heating System**

Biomass heating systems also known as biomass boilers burn organic matter—such as wood chips, agricultural residues or municipal waste—to generate heat for buildings. They are highly efficient heating systems, achieving near complete combustion of the biomass fuel through control of the fuel and air supply, and often incorporating automatic fuel handling transport systems. Biomass boilers consist of a boiler, a heat distribution system, and a fuel transportation system. The biomass heating system typically makes use of multiple heat sources, including a waste heat recovery system, a biomass combustion system, a peak load boiler, and a back-up boiler. The heat distribution system conveys hot water or steam from the heating plant to the loads that may be located within the same building as the heating plant, as in a system for a single institutional or industrial building, or, in the case of a "district heating" system, clusters of buildings located in the vicinity of the heating plant.

Biomass heating systems have higher capital costs than conventional boilers and need diligent operators. Balancing this, they can supply large quantities of heat on demand with very low fuel costs, depending on the origin of the fuel.

**Best Design Practice**

It's important to have storage space for the fuel and appropriate access to the boiler for loading the fuel. A local fuel supplier should be present in order to make the scheme viable.
The vent material must be specifically designed for wood appliances and there must be sufficient air movement for proper operation of the stove. Chimneys can be fitted with a lined flue.
A Biomass heating system installation should comply with all safety and building regulations. Wood can only be burned in exempted appliances, under the Clean Air Act.

**Advantages**

Producing energy from Biomass has both environmental and economic advantages. Although Biomass produces $CO_2$ it only releases the same amount that is absorbed whilst growing, which is why it is considered to be carbon neutral. Furthermore, Biomass can contribute to waste management by harnessing energy from products that are often disposed at landfill sites.
It is most cost effective and sustainable when a local fuel source is used, which results in local investment and employment, which in addition minimizes transport emissions.

**Planning Issues**

If the building is listed or is in an area of outstanding natural beauty, then it is required that the Local Authority Planning department is notified before a flue is fitted.

**Cost & Maintenance**
Stand-alone room heaters cost £2,000 to £4,000. Savings will depend on how much they are used and which fuel you are replacing. A Biomass stove which provides a detached home with 10% of annual space heating requirements could save around 840kg of $CO_2$ when installed in an electrically heated home. Due to the higher cost of Biomass pellets compared with other heating fuels, and the relatively low efficiency of the stove compared to a central heating system it will cost more to run.
The cost of Biomass boilers varies depending on the system choice; a typical 15kW pellet boiler would cost about £5,000-£14,000 installed, including the cost of the flue and commissioning process. A manual log feed system of the same size would be slightly cheaper. A wood pellet boiler could save around £750 a year in energy bills and around 6 tons of $CO_2$ per year when installed in an electrically heated home. In terms of biomass fuel costs, they generally depend on the distance between the dwelling and the supplier and whether large quantities can be bought.

**Feasibility on the site**
Biomass boilers should not be considered for this project due to the following reasons:

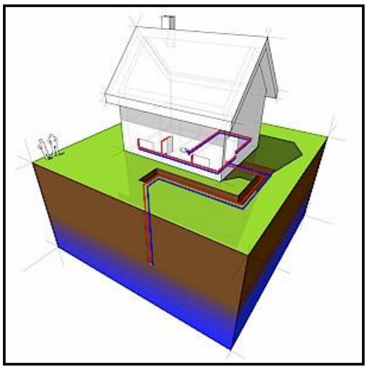
- Furthermore, in common with other types of combustion appliances, biomass boilers are potentially a source of air pollution. Pollutants associated with biomass combustion include particulate matter ($PM_{10}$/ $PM_{2.5}$) and nitrogen oxides ($NO_X$) EMISSIONS. These pollution emissions can have an impact on local air quality and affect human health. Biomass has recently been rejected by many London Boroughs as means of obtaining the on-site renewable contribution (and this will soon send ripples out to other regions). This is because of their associated flue emissions (which can be significantly higher than gas fired boilers) and the difficulty of ensuring the boiler will operate at its optimum efficiency, which is often quoted by designers at the initial design stages. Biomass flue emissions are often difficult to control because the quality of fuel can vary significantly between suppliers. Given this a bio fuel system may not be acceptable to the Council on planning grounds (e.g. concerns about associated flue emissions/impact on local 'Air Quality', increase in road traffic from pellet delivery lorries).
- Biomass fuel requires more onerous and frequent wood fuel silo (site storage issues) replenishing by delivery trucks- which in turn can cause site transportation issues that will need to be considered and addressed along with the impact on the other residents and neighborhood infrastructure.
- Restrictions on the type of fuel and appliance may apply to the development and according to studies commissioned by DEFRA the levels of particles emitted by the burning of wood chip or waste would be considered to outweigh the benefits of carbon reduction especially in an urban environment such as the proposed development site.
- Dependent on a fuel supply chain contract being confirmed.
- There is no suitable location for the plant and storage of the pellets on site at present.

## 8.6. Ground Source Heat Pumps (GSHP)

**Description of Ground Source Heat Pumps**
Ground-source heat pumps provide low temperature heat by extracting it from the ground or a body of water and provide cooling by reversing this process. Their principal application is space heating and

cooling, though many also supply hot water. They can even be used to maintain the integrity of building foundations in permafrost conditions, by keeping them frozen through the summer.

A ground-source heat pump (GSHP) system has three major components: the earth connection, a heat pump, and the heating or cooling distribution system. The earth connection is where heat transfer occurs. One common type of earth connection comprises tubing buried in horizontal trenches or vertical boreholes, or alternatively, submerged in a lake or pond. An antifreeze mixture, water or another heat-transfer fluid is circulated from the heat pump, through the tubing, and back to the heat pump in a "closed loop." "Open loop" earth connections draw water from a well or a body of water, transfer heat to or from the water, and then return it to the ground or the body of water.



Since the energy extracted from the ground exceeds the energy used to run the heat pump, GSHP "efficiencies" can exceed 100%, and routinely average 200 to 500% over a season. Due to the stable, moderate temperature of the ground, GSHP systems are more efficient than air-source heat pumps, which exchange heat with the outside air. GSHP systems are also more efficient than conventional heating and Air-conditioning technologies, and typically have lower maintenance costs. They require less space, especially when a liquid building loop replaces voluminous air ducts, and, since the tubing is located underground, are not prone to vandalism like conventional rooftop units. Peak electricity consumption during cooling season is lower than with conventional air-conditioning, so utility demand charges may be reduced. Heat pumps typically range in cooling capacity from 3.5 to 35 kW (1 to 20 tons of Cooling). A single unit in this range is sufficient for a house or small Commercial units Building. The heat pump usually generates hot or cold air to be distributed locally by conventional ducts.

**Advantages**

The efficiency of GSHP system is measured by the coefficient of performance (COP). This is the ratio of units of heat output for each unit of electricity used to drive the compressor and pump for the ground loop. Average COP known as seasonal efficiency, is around 3-4 although some systems may produce a greater rate of efficiency. This means that for every unit of electricity used to pump the heat, 3-4 units of heat are produced, making it an efficient way of heating a building. If grid electricity is used for the compressor and pump, then a range of energy suppliers should be consulted in order to benefit from the lower running costs.

**Cost & Savings**

A typical 8-12kW system costs £6,000-£12,000 (not including the price of distribution system). This can vary with property and location. When installed in an electrically heated home a GSHP could save as much as £900 a year on heating bills and almost 7 tonnes of $CO_2$ a year. Savings will vary depending on what fuel is being replaced.

**Feasibility on the site**

GSHP will not be studied any further for the following reasons:

- If an open loop configuration was to be adopted, a test borehole would be needed to assess the available resource. The test resource process is expensive and of course does not guarantee an acceptable resource in the ground. Additionally, a closed loop borehole configuration could not be used due to spatial limitations of the site.
- There are likely to be planning issues associated with borehole excavation and drilling.
- Running costs and maintenance may be minimal. However, installation is a costly affair. A GSHP solution would represent a relatively expensive option in comparison to other renewable technologies available.
- Additional electric immersion and pumps would be required to heat the GSHP water up to suitable temperature to be used around the building and it's likely a centralised plant area will also be required to house the circulation pumps.
- This technology is not recommended due to the increased plant energy consumption requirements in turn impacting the DER/TER score for the required energy strategy objectives.
- Furthermore, boreholes also destabilize the ground surface and may be considered a minus for environmentally friendly endeavours.

## 8.7. Combined Heat and Power (CHP) & Micro CHP

**Description of CHP**

The principle behind combined heat and power (cogeneration) is to recover the waste heat generated by the combustion of a fuel6 in an electricity generation system. This heat is often rejected to the environment, thereby wasting a significant portion of the energy available in the fuel that can otherwise be used for space heating and cooling, water heating, and industrial process heat and cooling loads in the vicinity of the plant. This cogeneration of electricity and heat greatly increases the overall efficiency of the system, anywhere from 25-55% to 60-90% depending on the equipment used, and the application.

A CHP installation comprises four subsystems: the power plant, the heat recovery and distribution system, an optional system for satisfying heating and/or cooling loads and a control system. A wide range of equipment can be used in the power plant, with the sole restriction being that the power equipment rejects heat at a temperature high enough to be useful for the thermal loads at hand. In a CHP system, heat may be recovered and distributed as hot water, conveyed from the plant to low temperature thermal loads in pipes for hot water, or for space heating.

**Advantages**

CHP can significantly reduce primary energy consumption, and can therefore have a major impact on CO2 emissions associated with the combustion of fossil fuels in conventional boilers. Each 1 kW of electrical capacity provided by CHP plant using fossil fuels has the potential to reduce annual CO2 emissions by around 0.6 tonnes compared to gas-fired boilers and fully grid-derived electricity. For plant which is fuelled by renewable energy sources the potential is much greater.

**Costs & Savings**

Capital costs for CHP installations are higher than for alternative systems, but this can be recovered over a relatively short period of time (typically 5–10 years) for installations where there is a demand for heat and power for 4500 hours or more each year. The cost effectiveness is very sensitive to the relative price of electricity and fossil fuel which have been subject to frequent variations since de-regulation of the energy supply industries.

**Micro CHP**

Micro CHP (Combined Heat & Power) is the simultaneous production of useful heat and power within the home. It works very much like the gas boiler in a central heating system and heats the home in just the same way. However, at the same time it generates electricity, some of which will be used in the dwelling and the remainder will be exported to the electricity grid. Effectively the micro CHP unit replaces the gas central heating boiler and provides heat and hot water as usual, but additionally provides the majority of the home's electricity needs. Although individual units produce, by definition, relatively small amounts of electricity, the significance of micro CHP lies in the potentially huge numbers of systems which may ultimately be installed in the millions of homes in the UK where natural gas is currently the dominant heating fuel.

**Feasibility on the site**

CHP has not been considered further for this project for the following reasons:

- The average maximum heating load of a new apartment (built to 2010 building regs) is approximately 3kW and therefore most individual heating systems with independent condensing gas boilers would be incapable of working at optimal efficiencies or achieving their stated SEDBUK rating due to boiler cycling.
- Traditional CHP should not be considered for this project due to the spatial constraints of the development plot and dwelling layouts. There is not suitable space in the development for CHP plant.
- Heat from the CHP plant could be utilized to drive an absorption chiller during the summer months (tri-generation), but due to the sustainable design of the building fabric, and the use of natural ventilation wherever possible, we anticipate that the cooling load will be minimal, making this a non-viable proposition.
- Micro-CHP is a relatively new concept and issues are raised in relation to unproven technology, inefficiency for shorter run cycles and lack of technical knowledge that can limit the practical application of micro CHP at present. In addition, high installation costs and estimated low life expectancy has also been taken into consideration as to its commercial unit's un-viability for this development scheme. Micro-CHP also has a lower FIT tariff rate and period duration and is only applicable for systems under 2kW.

## 8.8. Fuel Cells

**Description of Fuel Cells**

A fuel cell is a device that generates more electricity by a chemical reaction. Every fuel cell has two electrodes, one positive and one negative, called, respectively, the anode and cathode. The reactions that produce electricity take place at the electrodes.

Every fuel cell also has an electrolyte, which carries electrically charged particles from one electrode to the other, and a catalyst, which speeds the reactions at the electrodes. Hydrogen is the basic fuel, but fuel cells also require oxygen.

One great appeal of fuel cells is that they generate electricity with very little pollution—much of the hydrogen and oxygen used in generating electricity ultimately combine to form a harmless by product, namely water.

**Fuel Cell Operation**

The purpose of a fuel cell is to produce an electrical current that can be directed outside the cell to do work, such as powering an electric motor or illuminating a light bulb or a city. Because of the way electricity behaves, this current returns to the fuel cell, completing an electrical circuit. The chemical reactions that produce this current are the key to how a fuel cell works.

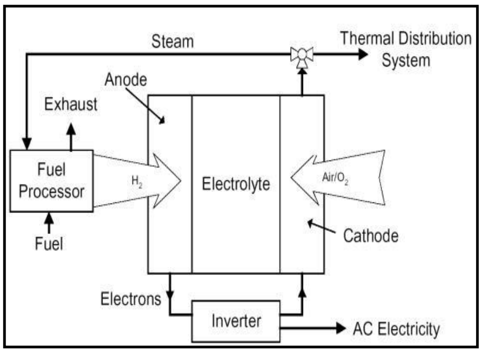
There are several kinds of fuel cells, and each operates a bit differently. But in general terms, hydrogen atoms enter a fuel cell at the anode where a chemical reaction strips them of their electrons. The hydrogen atoms are now "ionized," and carry a positive electrical charge. The negatively charged electrons provide the current through wires to do work. If alternating current (AC) is needed, the DC output of the fuel cell must be routed through a conversion device called an inverter.

**Advantages**

Even better, since fuel cells create electricity chemically, rather than by combustion, they are not subject to the thermodynamic laws that limit a conventional power plant. Therefore, fuel cells are more efficient in extracting energy from a fuel. Waste heat from some cells can also be harnessed, boosting system efficiency still further.

**Fuel Cells with Hydrogen from Renewable Sources**

Fuel cells can be used as CHP systems in buildings. There are currently several different systems under development using different chemical processes, which operate at different temperatures. They currently use natural gas as the fuel, which is reformed to produce hydrogen, the required fuel for the fuel cell. When and if hydrogen becomes available from renewable energy, fuel cell CHP from renewable sources may be possible in buildings.



## 8.9. Available Grants

### 8.9.1. Renewable Heat Incentive (RHI)

✓ **Domestic RHI tariff rates**

Table below specifies the current and future tariffs for each available renewable technology on the 31st of March 2016 (https://www.ofgem.gov.uk/environmental-programmes/domestic-renewable-heat-incentive-domestic-rhi/about-domestic-rhi/tariffs-and-payments-domestic-rhi). As the tariff keeps changing, it has to be checked at appropriate design stage.

| Applications submitted | Biomass boilers and stoves | Air source heat pumps | Ground source heat pumps | Solar thermal |
|---|---|---|---|---|
| 01/01/16 - 31/03/16 | 5.14p | 7.42p | 19.10p | 19.51p |
| 01/04/16 - 30/06/16* | 5.20p | 7.51p | 19.33p | 19.74p |
| 01/07/2016 - 30/09/2016** | If any new tariff changes are to be made due to degression, the next announcement by DECC would be by 1 June 2016. | | | |

✓ **Non-Domestic RHI tariff rates**

The table below specifies tariffs that apply for installations with an accreditation date on or after 1 April 2016 (https://www.ofgem.gov.uk/environmental-programmes/non-domestic-renewable-heat-incentive-rhi/tariffs-apply-non-domestic-rhi-great-britain).

| Tariff name | Eligible technology | Eligible sizes | Tariffs |
|---|---|---|---|
| Small commercial biomass | Solid biomass including solid biomass contained in waste | Less than 200 kWth | 3.62 |
| | | Tier 1 | |
| | | Less than 200 kWth | |
| | | Tier 2 | 0.96 |
| Medium commercial biomass | | 200 kWth and above & less than 1MWth Tier 1 | 5.24 |
| | | 200 kWth and above & less than 1MWth Tier 2 | 2.27 |
| Large commercial biomass | | 1MWth and above | 2.05 |
| Solid biomass CHP systems (commissioned on or after 4 December 2013) | Solid biomass CHP systems | all capacities | 4.22 |
| Water/Ground-source heat pumps | Ground-source heat pumps & Water-source heat pumps | all capacities Tier 1 | 8.95 |
| | | Tier 2 | 2.67 |

| | | | |
|---|---|---|---|
| Air-source heat pumps (commissioned on or after 4 December 2013) | Air-source heat pumps | all capacities | 2.57 |
| Deep geothermal (commissioned on or after 4 December 2013) | Deep geothermal | all capacities | 5.14 |
| All solar collectors | Solar collectors | Less than 200 kWth | 10.28 |
| Biomethane injection | Biomethane | On the first 40,000 MWh of eligible biomethane Tier 1 | 5.35 |
| | | Next 40,000 MWh of eligible biomethane Tier 2 | 3.14 |
| | | Remaining MWh of eligible biomethane Tier 3 | 2.42 |
| Small biogas combustion | Biogas combustion | Less than 200 kWth | 6.94 |
| Medium biogas combustion (commissioned on or after 4 December 2013) | | 200 kWth and above & less than 600 kWth | 5.45 |
| Large biogas combustion (commissioned on or after 4 December 2013) | | 600 kWth and above | 2.04 |

#### 8.9.2. Feed In Tariff (FIT)

The table below shows the listing of all generation tariff levels for installations before 1st April 2016, which is current data on the official webpage (http://www.fitariffs.co.uk/eligible/levels/). Tariffs after 1st April 2016 as per the degression table, but adjusted for RPI indexation and contingent degression. Therefore, the detailed tariff has to be checked at appropriate design stage.

| Energy Source | Scale | Type / Rate | Tariff (p/kWh) | |
|---|---|---|---|---|
| | | Non-PV | < 15/01/16 | > 8/2/16 |
| Anaerobic digestion | ≤250kW | | 9.12 | tba [1] |
| Anaerobic digestion | >250kW - 500kW | | 8.42 | tba [1] |
| Anaerobic digestion | >500kW | | 8.68 | tba [1] |
| Hydro | ≤15 kW | | 15.45 | 8.54 |
| Hydro | >15 - 100kW | | 14.43 | 8.54 |
| Hydro | >100kW - 500kW | | 11.40 | 6.14 |
| Hydro | >500kW - 2MW | | 8.91 | 6.14 |
| Hydro | >2MW - 5MW | | 2.43 | 4.43 |
| Micro-CHP | <2 kW | (limited) | 13.45 | tba [1] |
| Solar PV | ≤4 kW | Higher rate | 12.88 | 4.39 |
| Solar PV | ≤4 kW | Medium rate | 11.67 | |
| Solar PV | >4 - 10kW | Higher rate | 11.71 | 4.39 |
| Solar PV | >4 - 10kW | Medium rate | 10.54 | |
| Solar PV | >10 - 50kW | Higher rate | 11.71 | 4.59 |
| Solar PV | >10 - 50kW | Medium rate | 10.54 | |
| Solar PV | >50 - 150kW | Higher rate | 9.63 | 2.70 |
| Solar PV | >50 - 150kW | Medium rate | 8.67 | |
| Solar PV | >150 - 250kW | Higher rate | 9.21 | 2.70 |
| Solar PV | >150 - 250kW | Medium rate | 8.29 | |
| Solar PV | ≤250kW | Lower rate | 6.16 | |
| Solar PV | >250kW - 5MW | | 5.94 | 2.27 |
| Solar PV | >1MW - 5MW | | 5.94 | 0.87 |
| Solar PV | ≤5MW | Standalone | 4.44 | 0.87 |
| Wind | ≤100kW | | 13.73 | 8.53 |
| Wind | >100 - 500kW | | 10.85 | 8.53 |
| Wind | >500kW - 1.5MW | | 5.89 | 5.46 |
| Wind | >1.5MW - 5MW | | 2.49 | 0.86 |
| Any | existing systems transferred from RO | | 10.66 | 10.66 |

# 9. Appendix B – SAP Worksheets

## 9.1. SAP Worksheets at BE LEAN stage

# Block Compliance WorkSheet: 28 Redington Road_Rev C

## User Details

**Assessor Name:** 
**Stroma Number:** 
**Software Name:** Stroma FSAP
**Software Version:** Version: 1.0.3.11

## Calculation Details

| **Dwelling** | **DER** | **TER** | **DFEE** | **TFEE** | **TFA** |
|---|---|---|---|---|---|
| Flat 1 | 16.01 | 16.59 | 47.6 | 58.7 | 144 |
| Flat 2 | 12.34 | 12.84 | 36.6 | 45.9 | 229 |
| Flat 3 | 11.04 | 12 | 34.7 | 46.1 | 243 |
| Flat 4 | 11.91 | 13.04 | 33.8 | 45.8 | 178 |
| Flat 5 | 15.12 | 15.51 | 43.8 | 53.7 | 151 |
| Flat 6 | 14.77 | 15 | 45.2 | 54.3 | 167 |
| Flat 7 | 13.96 | 13.64 | 46.1 | 53.4 | 271 |
| Flat 8 | 19.42 | 18.68 | 64.5 | 72.4 | 153 |

## Calculation Summary

| | |
|---|---|
| Total Floor Area | 1536.00 |
| Average TER | 14.30 |
| Average DER | 13.96 |
| Average DFEE | 43.10 |
| Average TFEE | 52.76 |
| Compliance<br>% Improvement DER\|TER<br>% Improvement DFEE\|TFEE | Pass<br>2.38<br>18.31 |

# SAP WorkSheet: New dwelling design stage

User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | | **Stroma Number:** | |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.3.11 |

Property Address: Flat 1

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Basement | 75 | (1a) x | 2.8 | (2a) = | 210 | (3a) |
| Ground floor | 69 | (1b) x | 3.1 | (2b) = | 213.9 | (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 144 | (4) | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 423.9 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 4 | x 10 = | 40 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

DRAFT

| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 40 | ÷ (5) = | 0.09 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |

*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*

| | | | |
|---|---|---|---|
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.32 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.3 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

# SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.38 | 0.37 | 0.36 | 0.32 | 0.32 | 0.28 | 0.28 | 0.27 | 0.3 | 0.32 | 0.33 | 0.35 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 1.085 | x1/[1/( 1.2 )+ 0.04] | | = | 1.24 | | | (27) |
| Windows Type 2 | | | 1.02 | x1/[1/( 1.2 )+ 0.04] | | = | 1.17 | | | (27) |
| Floor | | | 75 | x | 0.12 | = | 9 | | | (28) |
| Walls Type1 | 14 | 2.1 | 11.9 | x | 0.12 | = | 1.43 | | | (29) |
| Walls Type2 | 30.8 | 0 | 30.8 | x | 0.11 | = | 3.42 | | | (29) |
| Walls Type3 | 20.44 | 0 | 20.44 | x | 0.11 | = | 2.27 | | | (29) |
| Walls Type4 | 33.6 | 14.74 | 18.86 | x | 0.12 | = | 2.26 | | | (29) |
| Walls Type5 | 8.4 | 0 | 8.4 | x | 0.11 | = | 0.91 | | | (29) |
| Walls Type6 | 8.4 | 0 | 8.4 | x | 0.11 | = | 0.91 | | | (29) |
| Walls Type7 | 5.88 | 0 | 5.88 | x | 0.11 | = | 0.65 | | | (29) |
| Walls Type8 | 12.9 | 0 | 12.9 | x | 0.12 | = | 1.55 | | | (29) |
| Walls Type9 | 17.36 | 0 | 17.36 | x | 0.11 | = | 1.88 | | | (29) |
| Walls Type10 | 24.8 | 0 | 24.8 | x | 0.12 | = | 2.98 | | | (29) |
| Walls Type11 | 30.69 | 0 | 30.69 | x | 0.11 | = | 3.32 | | | (29) |
| Walls Type12 | 30.69 | 0 | 30.69 | x | 0.13 | = | 3.99 | | | (29) |
| Total area of elements, m² | | | 312.96 | | | | | | | (31) |

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** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 53.12 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 0 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 46.94 | (36) |

*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 100.06 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 79.87 | 79.48 | 79.1 | 77.33 | 77 | 75.45 | 75.45 | 75.17 | 76.05 | 77 | 77.67 | 78.37 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 179.93 | 179.54 | 179.17 | 177.39 | 177.06 | 175.51 | 175.51 | 175.23 | 176.11 | 177.06 | 177.73 | 178.43 | |

Average = $Sum(39)_{1…12}$ /12= 177.39 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.25 | 1.25 | 1.24 | 1.23 | 1.23 | 1.22 | 1.22 | 1.22 | 1.22 | 1.23 | 1.23 | 1.24 | |

Average = $Sum(40)_{1…12}$ /12= 1.23 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |



## 4. Water heating energy requirement: kWh/year:

| | | |
|---|---|---|
| Assumed occupancy, N | 2.92 | (42) |

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

| | | |
|---|---|---|
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 103.65 | (43) |

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 114.02 | 109.87 | 105.73 | 101.58 | 97.43 | 93.29 | 93.29 | 97.43 | 101.58 | 105.73 | 109.87 | 114.02 | |

Total = $Sum(44)_{1…12}$ = 1243.84 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 169.09 | 147.88 | 152.6 | 133.04 | 127.66 | 110.16 | 102.08 | 117.14 | 118.54 | 138.14 | 150.79 | 163.75 | |

Total = $Sum(45)_{1…12}$ = 1630.87 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.36 | 22.18 | 22.89 | 19.96 | 19.15 | 16.52 | 15.31 | 17.57 | 17.78 | 20.72 | 22.62 | 24.56 | (46) |

Water storage loss:

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 1 | (47) |

If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter ‘0’ in (47)
Water storage loss:

| | | |
|---|---|---|
| a) If manufacturer’s declared loss factor is known (kWh/day): | 0 | (48) |
| Temperature factor from Table 2b | 0 | (49) |

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| | | | |
|---|---|---|---|
| Energy lost from water storage, kWh/year | (48) x (49) = | 1 | (50) |
| b) If manufacturer's declared cylinder loss factor is not known: | | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | | 0.03 | (51) |
| If community heating see section 4.3 | | | |
| Volume factor from Table 2a | | 4.93 | (52) |
| Temperature factor from Table 2b | | 0.6 | (53) |
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0.1 | (54) |
| Enter (50) or (54) in (55) | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 — 0 — (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 195.38 | 171.63 | 178.9 | 158.49 | 153.95 | 135.6 | 128.37 | 143.43 | 143.98 | 164.43 | 176.24 | 190.04 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 195.38 | 171.63 | 178.9 | 158.49 | 153.95 | 135.6 | 128.37 | 143.43 | 143.98 | 164.43 | 176.24 | 190.04 |

Output from water heater (annual)1…12 — 1940.44 — (64)



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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 74.83 | 65.98 | 69.35 | 62.25 | 61.06 | 54.64 | 52.55 | 57.56 | 57.42 | 64.54 | 68.15 | 73.06 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 73.13 | 64.95 | 52.82 | 39.99 | 29.89 | 25.24 | 27.27 | 35.45 | 47.58 | 60.41 | 70.5 | 75.16 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 468.53 | 473.39 | 461.14 | 435.06 | 402.13 | 371.19 | 350.52 | 345.65 | 357.91 | 383.99 | 416.91 | 447.86 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | (71) |

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Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 100.58 | 98.18 | 93.21 | 86.45 | 82.06 | 75.89 | 70.63 | 77.36 | 79.75 | 86.75 | 94.65 | 98.19 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 756.2 | 750.49 | 721.13 | 675.46 | 628.05 | 586.27 | 562.38 | 572.42 | 599.19 | 645.1 | 696.03 | 735.17 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 1.09 | x | 46.75 | x | 0.9 | x | 0.9 | = | 258.85 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 46.75 | x | 0.9 | x | 0.9 | = | 243.35 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 76.57 | x | 0.9 | x | 0.9 | = | 423.94 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 76.57 | x | 0.9 | x | 0.9 | = | 398.54 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 97.53 | x | 0.9 | x | 0.9 | = | 540.02 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 97.53 | x | 0.9 | x | 0.9 | = | 507.67 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 110.23 | x | 0.9 | x | 0.9 | = | 610.34 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 110.23 | x | 0.9 | x | 0.9 | = | 573.78 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 114.87 | x | 0.9 | x | 0.9 | = | 636.01 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 114.87 | x | 0.9 | x | 0.9 | = | 597.91 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 110.55 | x | 0.9 | x | 0.9 | = | 612.08 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 110.55 | x | 0.9 | x | 0.9 | = | 575.41 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 108.01 | x | 0.9 | x | 0.9 | = | 598.04 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 108.01 | x | 0.9 | x | 0.9 | = | 562.21 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 104.89 | x | 0.9 | x | 0.9 | = | 580.78 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 104.89 | x | 0.9 | x | 0.9 | = | 545.98 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 101.89 | x | 0.9 | x | 0.9 | = | 564.12 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 101.89 | x | 0.9 | x | 0.9 | = | 530.32 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 82.59 | x | 0.9 | x | 0.9 | = | 457.26 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 82.59 | x | 0.9 | x | 0.9 | = | 429.86 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 55.42 | x | 0.9 | x | 0.9 | = | 306.83 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 55.42 | x | 0.9 | x | 0.9 | = | 288.45 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 40.4 | x | 0.9 | x | 0.9 | = | 223.67 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 40.4 | x | 0.9 | x | 0.9 | = | 210.27 | (78) |



Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 502.2 | 822.48 | 1047.69 | 1184.12 | 1233.92 | 1187.48 | 1160.24 | 1126.76 | 1094.44 | 887.12 | 595.28 | 433.95 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1258.4 | 1572.96 | 1768.82 | 1859.58 | 1861.97 | 1773.75 | 1722.62 | 1699.18 | 1693.63 | 1532.22 | 1291.31 | 1169.12 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 0.99 | 0.97 | 0.94 | 0.88 | 0.77 | 0.61 | 0.44 | 0.47 | 0.67 | 0.89 | 0.98 | 0.99 | (86) |

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Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.87 | 20.13 | 20.4 | 20.67 | 20.87 | 20.97 | 20.99 | 20.99 | 20.95 | 20.7 | 20.22 | 19.82 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 19.88 | 19.88 | 19.88 | 19.89 | 19.9 | 19.9 | 19.9 | 19.91 | 19.9 | 19.9 | 19.89 | 19.89 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.99 | 0.97 | 0.92 | 0.85 | 0.71 | 0.51 | 0.34 | 0.36 | 0.58 | 0.85 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.42 | 18.78 | 19.17 | 19.54 | 19.78 | 19.89 | 19.9 | 19.9 | 19.87 | 19.58 | 18.93 | 18.35 | (90) |

fLA = Living area ÷ (4) = 0.35 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 18.93 | 19.25 | 19.6 | 19.94 | 20.16 | 20.27 | 20.29 | 20.29 | 20.24 | 19.97 | 19.38 | 18.86 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 18.93 | 19.25 | 19.6 | 19.94 | 20.16 | 20.27 | 20.29 | 20.29 | 20.24 | 19.97 | 19.38 | 18.86 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.98 | 0.96 | 0.92 | 0.85 | 0.73 | 0.54 | 0.37 | 0.4 | 0.61 | 0.86 | 0.96 | 0.99 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1237.69 | 1509.38 | 1625.86 | 1574.83 | 1352.4 | 966.16 | 643.19 | 675.78 | 1032.66 | 1314.25 | 1245.56 | 1154.73 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 2631.82 | 2577.3 | 2347.23 | 1957.71 | 1497.58 | 994.32 | 646.88 | 680.85 | 1082.19 | 1659.25 | 2183.37 | 2616.43 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1037.23 | 717.65 | 536.7 | 275.67 | 108.02 | 0 | 0 | 0 | 0 | 256.68 | 675.22 | 1087.51 | |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4694.67 (98)

Space heating requirement in kWh/m²/year 32.6 (99)



## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1649.84 | 1298.81 | 1331.74 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.86 | 0.92 | 0.91 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1412.38 | 1196.49 | 1213.73 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 1773.75 | 1722.62 | 1699.18 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 260.19 | 391.44 | 361.17 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 1012.8 (104)

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| | | | |
|---|---|---|---|
| Cooled fraction | f C = cooled area ÷ (4) = | 1 | (105) |

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

| | | | |
|---|---|---|---|
| | *Total = Sum(104)* = | 0 | (106) |

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 65.05 | 97.86 | 90.29 | 0 | 0 | 0 | 0 |

| | | | |
|---|---|---|---|
| | Total = Sum(107) = | 253.2 | (107) |
| Space cooling requirement in kWh/m²/year | (107) ÷ (4) = | 1.76 | (108) |

## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community boilers | | 1 | (303a) |
| Fraction of total space heat from Community boilers | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 4694.67 | |
| Space heat from Community boilers | (98) x (304a) x (305) x (306) = | 4929.4 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1940.44 | |
| If DHW from community scheme: Water heat from Community boilers | (64) x (303a) x (305) x (306) = | 2037.46 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 69.67 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 75.02 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 516.59 | (332) |

## 10b. Fuel costs – Community heating scheme

| | **Fuel** kWh/year | | **Fuel Price** (Table 12) | | **Fuel Cost** £/year | |
|---|---|---|---|---|---|---|
| Space heating from CHP | (307a) | x | 4.24 | x 0.01 = | 209.01 | (340a) |

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| | | | | | |
|---|---|---|---|---|---|
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 86.39 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 9.9 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 68.14 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 493.43 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 1.1 | (357) |
| **SAP rating (section12)** | | 84.7 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | **Energy kWh/year** | **Emission factor kg CO2/kWh** | | **Emissions kg CO2/year** | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1584.04 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 36.16 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1620.2 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.22 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1620.2 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 38.94 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 268.11 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | | 1927.25 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | | 13.38 | (384) |
| **EI rating (section 14)** | | | | | 86.34 | (385) |



## 13b. Primary Energy – Community heating scheme

| | | **Energy kWh/year** | **Primary factor** | | **P.Energy kWh/year** | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 8946.91 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 213.88 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 9160.8 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 9160.8 | (373) |

| | | | | | |
|---|---|---|---|---|---|
| Energy associated with space heating (secondary) | (309) x | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | 1.22 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | 9160.8 | (376) |
| Energy associated with space cooling | (315) x | 3.07 | = | 230.32 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | 3.07 | = | 1585.92 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | 10977.04 | (383) |

# SAP WorkSheet: New dwelling design stage

## User Details:

**Assessor Name:** | **Stroma Number:**

**Software Name:** Stroma FSAP 2012 | **Software Version:** Version: 1.0.3.11

## Property Address: Flat 2

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | | Av. Height(m) | | | Volume(m³) | |
|---|---|---|---|---|---|---|---|---|
| Ground floor | 229 | (1a) | x | 3.1 | (2a) | = | 709.9 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 229 | (4) | | | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) | | = | 709.9 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 5 | x 10 = | 50 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |



| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 50 | ÷ (5) = | 0.07 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |

*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*

| | | | |
|---|---|---|---|
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.3 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.27 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |
| Wind Factor (22a)m = (22)m ÷ 4 | | | | | | | | | | | | |
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

# SAP WorkSheet: New dwelling design stage

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.35 | 0.34 | 0.33 | 0.3 | 0.29 | 0.26 | 0.26 | 0.25 | 0.27 | 0.29 | 0.31 | 0.32 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (25) |



## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 0.9 | x1/[1/( 1.2 )+ 0.04] | | = | 1.03 | | | (27) |
| Windows Type 2 | | | 1.2 | x1/[1/( 1.2 )+ 0.04] | | = | 1.37 | | | (27) |
| Windows Type 3 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 4 | | | 1.2 | x1/[1/( 1.2 )+ 0.04] | | = | 1.37 | | | (27) |
| Walls Type1 | 33.17 | 8.1 | 25.07 | x | 0.12 | = | 3.01 | | | (29) |
| Walls Type2 | 48.36 | 0 | 48.36 | x | 0.11 | = | 5.24 | | | (29) |
| Walls Type3 | 28.52 | 0 | 28.52 | x | 0.12 | = | 3.42 | | | (29) |
| Walls Type4 | 63.24 | 4.9 | 58.34 | x | 0.12 | = | 7 | | | (29) |
| Walls Type5 | 14.26 | 0 | 14.26 | x | 0.11 | = | 1.54 | | | (29) |
| Total area of elements, m² | | | 187.55 | | | | | | | (31) |

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 34.37 (33)

Heat capacity Cm = S(A x k ) ((28)…(30) + (32) + (32a)…(32e) = 0 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

Thermal bridges : S (L x Y) calculated using Appendix K 28.13 (36)

*if details of thermal bridging are not known (36) = 0.15 x (31)*

Total fabric heat loss (33) + (36) = 62.51 (37)

# SAP WorkSheet: New dwelling design stage

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 131.35 | 130.8 | 130.26 | 127.72 | 127.24 | 125.03 | 125.03 | 124.62 | 125.88 | 127.24 | 128.2 | 129.21 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 193.86 | 193.31 | 192.77 | 190.22 | 189.75 | 187.54 | 187.54 | 187.12 | 188.39 | 189.75 | 190.71 | 191.72 | |

Average = Sum(39)$_{1…12}$ /12= 190.22 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 0.85 | 0.84 | 0.84 | 0.83 | 0.83 | 0.82 | 0.82 | 0.82 | 0.82 | 0.83 | 0.83 | 0.84 | |

Average = Sum(40)$_{1…12}$ /12= 0.83 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |

## 4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 3.04 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 106.39 (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*



| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)* | | | | | | | | | | | | | |
| (44)m= | 117.03 | 112.77 | 108.52 | 104.26 | 100.01 | 95.75 | 95.75 | 100.01 | 104.26 | 108.52 | 112.77 | 117.03 | |

Total = Sum(44)$_{1…12}$ = 1276.69 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 173.55 | 151.79 | 156.63 | 136.56 | 131.03 | 113.07 | 104.77 | 120.23 | 121.67 | 141.79 | 154.78 | 168.08 | |

Total = Sum(45)$_{1…12}$ = 1673.95 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 26.03 | 22.77 | 23.5 | 20.48 | 19.65 | 16.96 | 15.72 | 18.03 | 18.25 | 21.27 | 23.22 | 25.21 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 1 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0 (48)

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 1 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 4.93 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.1 (54)

Enter (50) or (54) in (55) 0.1 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 199.84 | 175.54 | 182.93 | 162 | 157.32 | 138.51 | 131.07 | 146.52 | 147.11 | 168.08 | 180.22 | 194.37 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 199.84 | 175.54 | 182.93 | 162 | 157.32 | 138.51 | 131.07 | 146.52 | 147.11 | 168.08 | 180.22 | 194.37 |

Output from water heater (annual)$_{1...12}$ — 1983.52 (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 76.32 | 67.28 | 70.69 | 63.41 | 62.18 | 55.6 | 53.45 | 58.59 | 58.46 | 65.76 | 69.47 | 74.5 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 108.63 | 96.48 | 78.46 | 59.4 | 44.4 | 37.49 | 40.51 | 52.65 | 70.67 | 89.73 | 104.73 | 111.64 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 593.78 | 599.95 | 584.42 | 551.36 | 509.64 | 470.42 | 444.22 | 438.06 | 453.59 | 486.64 | 528.37 | 567.59 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 102.58 | 100.12 | 95.01 | 88.08 | 83.57 | 77.23 | 71.84 | 78.75 | 81.2 | 88.38 | 96.49 | 100.13 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 922.06 | 913.61 | 874.97 | 815.91 | 754.68 | 702.21 | 673.64 | 686.53 | 722.52 | 781.82 | 846.66 | 896.43 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | Access Factor Table 6d | Area m² | Flux Table 6a | g_ Table 6b | FF Table 6c | Gains (W) |
|---|---|---|---|---|---|---|

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 1 | x | 2.8 | x | 19.64 | x | 0.9 | x | 0.9 | = | 40.09 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 38.42 | x | 0.9 | x | 0.9 | = | 78.42 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 63.27 | x | 0.9 | x | 0.9 | = | 129.15 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 92.28 | x | 0.9 | x | 0.9 | = | 188.36 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 113.09 | x | 0.9 | x | 0.9 | = | 230.84 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 115.77 | x | 0.9 | x | 0.9 | = | 236.31 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 110.22 | x | 0.9 | x | 0.9 | = | 224.98 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 94.68 | x | 0.9 | x | 0.9 | = | 193.25 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 73.59 | x | 0.9 | x | 0.9 | = | 150.21 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 45.59 | x | 0.9 | x | 0.9 | = | 93.06 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 24.49 | x | 0.9 | x | 0.9 | = | 49.99 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 16.15 | x | 0.9 | x | 0.9 | = | 32.97 | (76) |
| South | 0.9x | 1 | x | 0.9 | x | 46.75 | x | 0.9 | x | 0.9 | = | 153.37 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 46.75 | x | 0.9 | x | 0.9 | = | 81.8 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 46.75 | x | 0.9 | x | 0.9 | = | 40.9 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 76.57 | x | 0.9 | x | 0.9 | = | 251.18 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 76.57 | x | 0.9 | x | 0.9 | = | 133.96 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 76.57 | x | 0.9 | x | 0.9 | = | 66.98 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 97.53 | x | 0.9 | x | 0.9 | = | 319.96 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 97.53 | x | 0.9 | x | 0.9 | = | 170.65 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 97.53 | x | 0.9 | x | 0.9 | = | 85.32 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 110.23 | x | 0.9 | x | 0.9 | = | 361.62 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 110.23 | x | 0.9 | x | 0.9 | = | 192.87 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 110.23 | x | 0.9 | x | 0.9 | = | 96.43 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 114.87 | x | 0.9 | x | 0.9 | = | 376.83 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 114.87 | x | 0.9 | x | 0.9 | = | 200.98 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 114.87 | x | 0.9 | x | 0.9 | = | 100.49 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 110.55 | x | 0.9 | x | 0.9 | = | 362.65 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 110.55 | x | 0.9 | x | 0.9 | = | 193.41 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 110.55 | x | 0.9 | x | 0.9 | = | 96.71 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 108.01 | x | 0.9 | x | 0.9 | = | 354.33 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 108.01 | x | 0.9 | x | 0.9 | = | 188.98 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 108.01 | x | 0.9 | x | 0.9 | = | 94.49 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 104.89 | x | 0.9 | x | 0.9 | = | 344.11 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 104.89 | x | 0.9 | x | 0.9 | = | 183.52 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 104.89 | x | 0.9 | x | 0.9 | = | 91.76 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 101.89 | x | 0.9 | x | 0.9 | = | 334.24 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 101.89 | x | 0.9 | x | 0.9 | = | 178.26 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 101.89 | x | 0.9 | x | 0.9 | = | 89.13 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 82.59 | x | 0.9 | x | 0.9 | = | 270.92 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 82.59 | x | 0.9 | x | 0.9 | = | 144.49 | (78) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 1.2 | x | 82.59 | x | 0.9 | x | 0.9 | = | 72.25 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 55.42 | x | 0.9 | x | 0.9 | = | 181.8 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 55.42 | x | 0.9 | x | 0.9 | = | 96.96 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 55.42 | x | 0.9 | x | 0.9 | = | 48.48 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 40.4 | x | 0.9 | x | 0.9 | = | 132.53 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 40.4 | x | 0.9 | x | 0.9 | = | 70.68 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 40.4 | x | 0.9 | x | 0.9 | = | 35.34 | (78) |

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 316.16 | 530.55 | 705.08 | 839.29 | 909.15 | 889.08 | 862.78 | 812.64 | 751.83 | 580.72 | 377.22 | 271.51 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1238.21 | 1444.16 | 1580.05 | 1655.2 | 1663.83 | 1591.29 | 1536.41 | 1499.17 | 1474.36 | 1362.54 | 1223.88 | 1167.94 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 1 | 0.99 | 0.96 | 0.89 | 0.72 | 0.53 | 0.57 | 0.81 | 0.97 | 1 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 20.13 | 20.27 | 20.46 | 20.69 | 20.88 | 20.98 | 21 | 21 | 20.95 | 20.72 | 20.38 | 20.11 | (87) |



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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 20.21 | 20.22 | 20.22 | 20.23 | 20.23 | 20.24 | 20.24 | 20.24 | 20.23 | 20.23 | 20.22 | 20.22 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 1 | 1 | 0.99 | 0.95 | 0.86 | 0.65 | 0.44 | 0.48 | 0.74 | 0.96 | 1 | 1 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 19.04 | 19.25 | 19.53 | 19.86 | 20.1 | 20.22 | 20.24 | 20.24 | 20.2 | 19.9 | 19.41 | 19.01 | (90) |

fLA = Living area ÷ (4) = | 0.23 | (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.29 | 19.49 | 19.75 | 20.05 | 20.29 | 20.4 | 20.41 | 20.42 | 20.37 | 20.09 | 19.63 | 19.27 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.29 | 19.49 | 19.75 | 20.05 | 20.29 | 20.4 | 20.41 | 20.42 | 20.37 | 20.09 | 19.63 | 19.27 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 1 | 0.99 | 0.98 | 0.95 | 0.86 | 0.67 | 0.46 | 0.5 | 0.76 | 0.96 | 0.99 | 1 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1235.36 | 1434.91 | 1552.7 | 1571.26 | 1429.08 | 1058.6 | 713.03 | 747.56 | 1115.46 | 1302.45 | 1216.43 | 1166.06 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 2906.87 | 2819.87 | 2553.41 | 2121.85 | 1629.25 | 1087.52 | 715.4 | 751.33 | 1181.93 | 1800.56 | 2390.38 | 2888.42 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1243.61 | 930.7 | 744.53 | 396.42 | 148.93 | 0 | 0 | 0 | 0 | 370.59 | 845.24 | 1281.44 | |

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Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 5961.46 (98)

Space heating requirement in kWh/m²/year 26.03 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1762.83 | 1387.76 | 1422.15 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.82 | 0.91 | 0.89 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1447.03 | 1261.66 | 1267.57 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 1591.29 | 1536.41 | 1499.17 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 103.86 | 204.42 | 172.31 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 480.59 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 25.97 | 51.1 | 43.08 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 120.15 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 0.52 (108)



## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none 0 (301)

Fraction of space heat from community system 1 – (301) = 1 (302)

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

Fraction of heat from Community boilers 1 (303a)

Fraction of total space heat from Community boilers (302) x (303a) = 1 (304a)

Factor for control and charging method (Table 4c(3)) for community heating system 1 (305)

Distribution loss factor (Table 12c) for community heating system 1.05 (306)

**Space heating** **kWh/year**

Annual space heating requirement 5961.46

Space heat from Community boilers (98) x (304a) x (305) x (306) = 6259.54 (307a)

Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) 0 (308

Space heating requirement from secondary/supplementary system (98) x (301) x 100 ÷ (308) = 0 (309)

**Water heating**

Annual water heating requirement 1983.52

If DHW from community scheme:

| | | | |
|---|---|---|---|
| Water heat from Community boilers | (64) x (303a) x (305) x (306) = | 2082.69 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 83.42 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 35.6 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f):<br>mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 767.34 | (332) |

## 10b. Fuel costs – Community heating scheme

| | **Fuel** kWh/year | **Fuel Price** (Table 12) | | **Fuel Cost** £/year | |
|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | 4.24 | x 0.01 = | 265.4 | (340a) |
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 88.31 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 4.7 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 101.21 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 579.62 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 0.89 | (357) |
| **SAP rating (section12)** | | 87.61 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | **Energy** kWh/year | **Emission factor** kg CO2/kWh | | **Emissions** kg CO2/year | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP)<br>Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1896.76 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 43.3 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1940.06 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1940.06 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 18.48 | (377) |

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| | | | | | |
|---|---|---|---|---|---|
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | 0.52 | = | 398.25 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | 2356.78 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | 10.29 | (384) |
| **EI rating (section 14)** | | | | 88.47 | (385) |

## 13b. Primary Energy – Community heating scheme

| | | Energy kWh/year | Primary factor | | P.Energy kWh/year | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 10713.18 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 256.11 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 10969.29 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 10969.29 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | | 10969.29 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = | 109.29 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = | 2355.75 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | | 13434.32 | (383) |

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User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | | **Stroma Number:** | |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.3.11 |

Property Address: Flat 3

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 65 | (1a) x | 3.1 | (2a) = | 201.5 | (3a) |
| First floor | 178 | (1b) x | 2.9 | (2b) = | 516.2 | (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 243 | (4) | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 717.7 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 4 | x 10 = | 40 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

| | | | | Air changes per hour | |
|---|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = | (6a)+(6b)+(7a)+(7b)+(7c) = | 40 | ÷ (5) = | 0.06 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |
| *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | | |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.28 | (18) |
| *Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used* | | | |
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.26 | (21) |

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

Wind Factor (22a)m = (22)m ÷ 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.33 | 0.32 | 0.32 | 0.29 | 0.28 | 0.25 | 0.25 | 0.24 | 0.26 | 0.28 | 0.29 | 0.31 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 1.5 | x1/[1/( 1.2 )+ 0.04] | | = | 1.72 | | | (27) |
| Windows Type 2 | | | 2.44 | x1/[1/( 1.2 )+ 0.04] | | = | 2.79 | | | (27) |
| Windows Type 3 | | | 0.9 | x1/[1/( 1.2 )+ 0.04] | | = | 1.03 | | | (27) |
| Windows Type 4 | | | 1.4 | x1/[1/( 1.2 )+ 0.04] | | = | 1.6 | | | (27) |
| Windows Type 5 | | | 0.91 | x1/[1/( 1.2 )+ 0.04] | | = | 1.04 | | | (27) |
| Windows Type 6 | | | 1.58 | x1/[1/( 1.2 )+ 0.04] | | = | 1.81 | | | (27) |
| Windows Type 7 | | | 1.6 | x1/[1/( 1.2 )+ 0.04] | | = | 1.83 | | | (27) |
| Rooflights | | | 0.5 | x1/[1/(1.3) + 0.04] | | = | 0.65 | | | (27b) |
| Walls Type1 | 20.16 | 9.5 | 10.66 | x | 0.12 | = | 1.28 | | | (29) |
| Walls Type2 | 11.89 | 0 | 11.89 | x | 0.12 | = | 1.43 | | | (29) |
| Walls Type3 | 6.51 | 6.37 | 0.14 | x | 0.11 | = | 0.02 | | | (29) |
| Walls Type4 | 14.26 | 0 | 14.26 | x | 0.12 | = | 1.71 | | | (29) |
| Walls Type5 | 35.67 | 28.5 | 7.17 | x | 0.12 | = | 0.86 | | | (29) |
| Walls Type6 | 78.3 | 0 | 78.3 | x | 0.12 | = | 9.4 | | | (29) |
| Roof | 25 | 1 | 24 | x | 0.13 | = | 3.12 | | | (30) |
| Total area of elements, m² | | | 193.89 | | | | | | | (31) |

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** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 71.53 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 216 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 29.08 | (36) |

*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 100.61 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 131.4 | 130.9 | 130.4 | 128.08 | 127.65 | 125.63 | 125.63 | 125.25 | 126.41 | 127.65 | 128.53 | 129.45 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 232.02 | 231.51 | 231.02 | 228.7 | 228.26 | 226.24 | 226.24 | 225.87 | 227.02 | 228.26 | 229.14 | 230.06 | |

Average = $Sum(39)_{1…12}$ /12= 228.69 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 0.95 | 0.95 | 0.95 | 0.94 | 0.94 | 0.93 | 0.93 | 0.93 | 0.93 | 0.94 | 0.94 | 0.95 | |

Average = $Sum(40)_{1…12}$ /12= 0.94 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |



## 4. Water heating energy requirement: kWh/year:

| | | |
|---|---|---|
| Assumed occupancy, N | 3.06 | (42) |

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

| | | |
|---|---|---|
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 106.82 | (43) |

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 117.51 | 113.23 | 108.96 | 104.69 | 100.41 | 96.14 | 96.14 | 100.41 | 104.69 | 108.96 | 113.23 | 117.51 |

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

Total = $Sum(44)_{1…12}$ = 1281.88 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 174.26 | 152.41 | 157.27 | 137.11 | 131.56 | 113.53 | 105.2 | 120.72 | 122.16 | 142.37 | 155.4 | 168.76 |

Total = $Sum(45)_{1…12}$ = 1680.75 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 26.14 | 22.86 | 23.59 | 20.57 | 19.73 | 17.03 | 15.78 | 18.11 | 18.32 | 21.36 | 23.31 | 25.31 | (46) |

Water storage loss:

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 1 | (47) |

If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter ‘0’ in (47)
Water storage loss:

| | | |
|---|---|---|
| a) If manufacturer’s declared loss factor is known (kWh/day): | 0 | (48) |
| Temperature factor from Table 2b | 0 | (49) |

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| | | | |
|---|---|---|---|
| Energy lost from water storage, kWh/year | (48) x (49) = | 1 | (50) |
| b) If manufacturer's declared cylinder loss factor is not known: | | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | | 0.03 | (51) |
| If community heating see section 4.3 | | | |
| Volume factor from Table 2a | | 4.93 | (52) |
| Temperature factor from Table 2b | | 0.6 | (53) |
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0.1 | (54) |
| Enter (50) or (54) in (55) | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 — 0 — (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 200.55 | 176.15 | 183.56 | 162.56 | 157.85 | 138.97 | 131.49 | 147.01 | 147.61 | 168.66 | 180.85 | 195.05 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 200.55 | 176.15 | 183.56 | 162.56 | 157.85 | 138.97 | 131.49 | 147.01 | 147.61 | 168.66 | 180.85 | 195.05 | |

Output from water heater (annual)$_{1...12}$ — 1990.32 — (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 76.55 | 67.48 | 70.9 | 63.6 | 62.35 | 55.76 | 53.59 | 58.75 | 58.63 | 65.95 | 69.68 | 74.72 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 91.44 | 81.22 | 66.05 | 50 | 37.38 | 31.56 | 34.1 | 44.32 | 59.49 | 75.53 | 88.16 | 93.98 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 612.35 | 618.7 | 602.69 | 568.6 | 525.57 | 485.13 | 458.11 | 451.76 | 467.77 | 501.86 | 544.89 | 585.33 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 102.89 | 100.42 | 95.3 | 88.33 | 83.81 | 77.44 | 72.03 | 78.96 | 81.43 | 88.64 | 96.78 | 100.43 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 924.24 | 917.9 | 881.6 | 824.5 | 764.32 | 711.69 | 681.8 | 692.6 | 726.25 | 783.59 | 847.39 | 897.31 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 1.58 | x | 10.63 | x | 0.9 | x | 0.9 | = | 61.24 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 10.63 | x | 0.9 | x | 0.9 | = | 12.4 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 20.32 | x | 0.9 | x | 0.9 | = | 117.03 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 20.32 | x | 0.9 | x | 0.9 | = | 23.7 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 34.53 | x | 0.9 | x | 0.9 | = | 198.86 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 34.53 | x | 0.9 | x | 0.9 | = | 40.28 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 55.46 | x | 0.9 | x | 0.9 | = | 319.43 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 55.46 | x | 0.9 | x | 0.9 | = | 64.69 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 74.72 | x | 0.9 | x | 0.9 | = | 430.3 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 74.72 | x | 0.9 | x | 0.9 | = | 87.15 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 79.99 | x | 0.9 | x | 0.9 | = | 460.64 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 79.99 | x | 0.9 | x | 0.9 | = | 93.29 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 74.68 | x | 0.9 | x | 0.9 | = | 430.07 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 74.68 | x | 0.9 | x | 0.9 | = | 87.1 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 59.25 | x | 0.9 | x | 0.9 | = | 341.21 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 59.25 | x | 0.9 | x | 0.9 | = | 69.1 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 41.52 | x | 0.9 | x | 0.9 | = | 239.1 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 41.52 | x | 0.9 | x | 0.9 | = | 48.42 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 24.19 | x | 0.9 | x | 0.9 | = | 139.31 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 24.19 | x | 0.9 | x | 0.9 | = | 28.21 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 13.12 | x | 0.9 | x | 0.9 | = | 75.55 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 13.12 | x | 0.9 | x | 0.9 | = | 15.3 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 8.86 | x | 0.9 | x | 0.9 | = | 51.05 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 8.86 | x | 0.9 | x | 0.9 | = | 10.34 | (74) |
| South | 0.9x | 1 | x | 0.91 | x | 46.75 | x | 0.9 | x | 0.9 | = | 217.1 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 76.57 | x | 0.9 | x | 0.9 | = | 355.56 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 97.53 | x | 0.9 | x | 0.9 | = | 452.92 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.23 | x | 0.9 | x | 0.9 | = | 511.9 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 114.87 | x | 0.9 | x | 0.9 | = | 533.43 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.55 | x | 0.9 | x | 0.9 | = | 513.35 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 108.01 | x | 0.9 | x | 0.9 | = | 501.58 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 104.89 | x | 0.9 | x | 0.9 | = | 487.1 | (78) |

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 0.91 | x | 101.89 | x | 0.9 | x | 0.9 | = | 473.13 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 82.59 | x | 0.9 | x | 0.9 | = | 383.51 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 55.42 | x | 0.9 | x | 0.9 | = | 257.34 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 40.4 | x | 0.9 | x | 0.9 | = | 187.6 | (78) |
| West | 0.9x | 1 | x | 1.5 | x | 19.64 | x | 0.9 | x | 0.9 | = | 107.38 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 19.64 | x | 0.9 | x | 0.9 | = | 174.68 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 19.64 | x | 0.9 | x | 0.9 | = | 25.77 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 19.64 | x | 0.9 | x | 0.9 | = | 100.22 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 38.42 | x | 0.9 | x | 0.9 | = | 210.06 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 38.42 | x | 0.9 | x | 0.9 | = | 341.7 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 38.42 | x | 0.9 | x | 0.9 | = | 50.42 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 38.42 | x | 0.9 | x | 0.9 | = | 196.06 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 63.27 | x | 0.9 | x | 0.9 | = | 345.95 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 63.27 | x | 0.9 | x | 0.9 | = | 562.74 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 63.27 | x | 0.9 | x | 0.9 | = | 83.03 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 63.27 | x | 0.9 | x | 0.9 | = | 322.88 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 92.28 | x | 0.9 | x | 0.9 | = | 504.54 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 92.28 | x | 0.9 | x | 0.9 | = | 820.72 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 92.28 | x | 0.9 | x | 0.9 | = | 121.09 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 92.28 | x | 0.9 | x | 0.9 | = | 470.91 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 113.09 | x | 0.9 | x | 0.9 | = | 618.33 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 113.09 | x | 0.9 | x | 0.9 | = | 1005.82 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 113.09 | x | 0.9 | x | 0.9 | = | 148.4 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 113.09 | x | 0.9 | x | 0.9 | = | 577.11 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 115.77 | x | 0.9 | x | 0.9 | = | 632.98 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 115.77 | x | 0.9 | x | 0.9 | = | 1029.64 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 115.77 | x | 0.9 | x | 0.9 | = | 151.91 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 115.77 | x | 0.9 | x | 0.9 | = | 590.78 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 110.22 | x | 0.9 | x | 0.9 | = | 602.62 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 110.22 | x | 0.9 | x | 0.9 | = | 980.26 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 110.22 | x | 0.9 | x | 0.9 | = | 144.63 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 110.22 | x | 0.9 | x | 0.9 | = | 562.44 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 94.68 | x | 0.9 | x | 0.9 | = | 517.64 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 94.68 | x | 0.9 | x | 0.9 | = | 842.03 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 94.68 | x | 0.9 | x | 0.9 | = | 124.23 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 94.68 | x | 0.9 | x | 0.9 | = | 483.13 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 73.59 | x | 0.9 | x | 0.9 | = | 402.35 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 73.59 | x | 0.9 | x | 0.9 | = | 654.49 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 73.59 | x | 0.9 | x | 0.9 | = | 96.56 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 73.59 | x | 0.9 | x | 0.9 | = | 375.53 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 45.59 | x | 0.9 | x | 0.9 | = | 249.26 | (80) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.9x | 1 | x | 2.44 | x | 45.59 | x | 0.9 | x | 0.9 | = | 405.46 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 45.59 | x | 0.9 | x | 0.9 | = | 59.82 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 45.59 | x | 0.9 | x | 0.9 | = | 232.64 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 24.49 | x | 0.9 | x | 0.9 | = | 133.89 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 24.49 | x | 0.9 | x | 0.9 | = | 217.8 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 24.49 | x | 0.9 | x | 0.9 | = | 32.13 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 24.49 | x | 0.9 | x | 0.9 | = | 124.97 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 16.15 | x | 0.9 | x | 0.9 | = | 88.31 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 16.15 | x | 0.9 | x | 0.9 | = | 143.65 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 16.15 | x | 0.9 | x | 0.9 | = | 21.19 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 16.15 | x | 0.9 | x | 0.9 | = | 82.42 | (80) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 26 | x | 0.7 | x | 0.7 | = | 11.47 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 54 | x | 0.7 | x | 0.7 | = | 23.81 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 96 | x | 0.7 | x | 0.7 | = | 42.34 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 150 | x | 0.7 | x | 0.7 | = | 66.15 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 192 | x | 0.7 | x | 0.7 | = | 84.67 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 200 | x | 0.7 | x | 0.7 | = | 88.2 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 189 | x | 0.7 | x | 0.7 | = | 83.35 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 157 | x | 0.7 | x | 0.7 | = | 69.24 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 115 | x | 0.7 | x | 0.7 | = | 50.71 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 66 | x | 0.7 | x | 0.7 | = | 29.11 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 33 | x | 0.7 | x | 0.7 | = | 14.55 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 21 | x | 0.7 | x | 0.7 | = | 9.26 | (82) |



Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 710.27 | 1318.35 | 2048.99 | 2879.43 | 3485.22 | 3560.8 | 3392.05 | 2933.68 | 2340.29 | 1527.32 | 871.54 | 593.82 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1634.51 | 2236.26 | 2930.59 | 3703.93 | 4249.54 | 4272.49 | 4073.85 | 3626.28 | 3066.54 | 2310.91 | 1718.93 | 1491.12 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 0.98 | 0.9 | 0.71 | 0.5 | 0.34 | 0.24 | 0.29 | 0.51 | 0.87 | 0.99 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 20.1 | 20.38 | 20.72 | 20.94 | 20.99 | 21 | 21 | 21 | 20.99 | 20.85 | 20.4 | 20.05 | (87) |

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

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

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 1 | 0.97 | 0.88 | 0.67 | 0.45 | 0.29 | 0.2 | 0.23 | 0.44 | 0.83 | 0.98 | 1 | (89) |

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

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.92 | 19.33 | 19.8 | 20.07 | 20.13 | 20.14 | 20.14 | 20.14 | 20.13 | 19.98 | 19.37 | 18.85 | (90) |

fLA = Living area ÷ (4) = 0.18 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.13 | 19.52 | 19.96 | 20.23 | 20.28 | 20.29 | 20.29 | 20.29 | 20.29 | 20.13 | 19.55 | 19.06 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.13 | 19.52 | 19.96 | 20.23 | 20.28 | 20.29 | 20.29 | 20.29 | 20.29 | 20.13 | 19.55 | 19.06 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Utilisation factor for gains, hm:** | | | | | | | | | | | | | |
| (94)m= | 0.99 | 0.97 | 0.88 | 0.67 | 0.46 | 0.3 | 0.21 | 0.24 | 0.46 | 0.83 | 0.98 | 1 | (94) |
| **Useful gains, hmGm , W = (94)m x (84)m** | | | | | | | | | | | | | |
| (95)m= | 1623.41 | 2165.17 | 2574.47 | 2488.27 | 1948.07 | 1287.24 | 835.49 | 879.42 | 1397.23 | 1915.27 | 1683.66 | 1484.76 | (95) |
| **Monthly average external temperature from Table 8** | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| **Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ]** | | | | | | | | | | | | | |
| (97)m= | 3440.76 | 3384.2 | 3109.38 | 2590.77 | 1958.82 | 1287.94 | 835.54 | 879.56 | 1404.54 | 2176.38 | 2853.24 | 3418.64 | (97) |
| **Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m** | | | | | | | | | | | | | |
| (98)m= | 1352.11 | 819.19 | 397.98 | 73.8 | 8 | 0 | 0 | 0 | 0 | 194.26 | 842.1 | 1438.81 | |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 5126.24 (98)

Space heating requirement in kWh/m²/year 21.1 (99)



## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10)** | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 2126.66 | 1674.18 | 1716.58 | 0 | 0 | 0 | 0 | (100) |
| **Utilisation factor for loss hm** | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.99 | 1 | 0.99 | 0 | 0 | 0 | 0 | (101) |
| **Useful loss, hmLm (Watts) = (100)m x (101)m** | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 2109.98 | 1669.3 | 1706.21 | 0 | 0 | 0 | 0 | (102) |
| **Gains (solar gains calculated for applicable weather region, see Table 10)** | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 4272.49 | 4073.85 | 3626.28 | 0 | 0 | 0 | 0 | (103) |
| ***Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m*** set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 1557.01 | 1788.98 | 1428.54 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 4774.52 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 389.25 | 447.24 | 357.13 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 1193.63 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 4.91 (108)

## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

# SAP WorkSheet: New dwelling design stage

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community boilers | | 1 | (303a) |
| Fraction of total space heat from Community boilers | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 5126.24 | |
| Space heat from Community boilers | (98) x (304a) x (305) x (306) = | 5382.56 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1990.32 | |
| If DHW from community scheme:<br>Water heat from Community boilers | (64) x (303a) x (305) x (306) = | 2089.84 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 74.72 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 353.67 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f):<br>mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 645.95 | (332) |



## 10b. Fuel costs – Community heating scheme

| | Fuel kWh/year | Fuel Price (Table 12) | | Fuel Cost £/year | |
|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | 4.24 | x 0.01 = | 228.22 | (340a) |
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 88.61 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 46.65 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 85.2 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 568.68 | (355) |

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## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 0.83 | (357) |
| **SAP rating (section12)** | | 88.43 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | **Energy kWh/year** | **Emission factor kg CO2/kWh** | | **Emissions kg CO2/year** | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1698.99 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 38.78 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1737.77 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1737.77 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 183.55 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 335.25 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | | 2256.57 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | | 9.29 | (384) |
| **EI rating (section 14)** | | | | | 89.5 | (385) |



## 13b. Primary Energy – Community heating scheme

| | | **Energy kWh/year** | **Primary factor** | | **P.Energy kWh/year** | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 9596.12 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 229.4 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 9825.53 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 9825.53 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | | 9825.53 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = | 1085.76 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = | 1983.06 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | | 12894.35 | (383) |

# SAP WorkSheet: New dwelling design stage

## User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | | **Stroma Number:** | |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.3.11 |

## Property Address: Flat 4

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 178 | (1a) x | 2.9 | (2a) = | 516.2 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 178 | (4) | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 516.2 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 5 | x 10 = | 50 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

DRAFT

| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 50 | ÷ (5) = | 0.1 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction<br>*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | 0 | (11) |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.32 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.3 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |
| Wind Factor (22a)m = (22)m ÷ 4 | | | | | | | | | | | | |
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

# SAP WorkSheet: New dwelling design stage

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.38 | 0.37 | 0.36 | 0.33 | 0.32 | 0.28 | 0.28 | 0.28 | 0.3 | 0.32 | 0.33 | 0.35 |

*Calculate effective air change rate for the applicable case*

| | | |
|---|---|---|
| If mechanical ventilation: | 0 | (23a) |
| If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) | 0 | (23b) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = | 0 | (23c) |

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (25) |



## 3. Heat losses and heat loss parameter:

| **ELEMENT** | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 0.91 | x1/[1/( 1.2 )+ 0.04] | | = | 1.04 | | | (27) |
| Windows Type 2 | | | 0.97 | x1/[1/( 1.2 )+ 0.04] | | = | 1.11 | | | (27) |
| Windows Type 3 | | | 0.79 | x1/[1/( 1.2 )+ 0.04] | | = | 0.9 | | | (27) |
| Windows Type 4 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 5 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 6 | | | 0.78 | x1/[1/( 1.2 )+ 0.04] | | = | 0.89 | | | (27) |
| Windows Type 7 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 8 | | | 2.5 | x1/[1/( 1.2 )+ 0.04] | | = | 2.86 | | | (27) |
| Walls Type1 | 28.13 | 0 | 28.13 | x | 0.12 | = | 3.38 | | | (29) |
| Walls Type2 | 21.46 | 0 | 21.46 | x | 0.11 | = | 2.32 | | | (29) |
| Walls Type3 | 28.13 | 0 | 28.13 | x | 0.12 | = | 3.38 | | | (29) |
| Walls Type4 | 59.45 | 12.7 | 46.75 | x | 0.12 | = | 5.61 | | | (29) |
| Total area of elements, m² | | | 156.17 | | | | | | | (31) |

* *for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

** *include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 50.26 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 0 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f*

*can be used instead of a detailed calculation.*

Thermal bridges : S (L x Y) calculated using Appendix K | 23.43 | (36)

*if details of thermal bridging are not known (36) = 0.15 x (31)*

Total fabric heat loss (33) + (36) = | 73.68 | (37)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 97.45 | 96.97 | 96.5 | 94.31 | 93.9 | 91.99 | 91.99 | 91.63 | 92.72 | 93.9 | 94.73 | 95.6 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 171.13 | 170.65 | 170.19 | 167.99 | 167.58 | 165.67 | 165.67 | 165.32 | 166.41 | 167.58 | 168.41 | 169.28 |

Average = Sum(39)1…12 /12= | 167.99 | (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 0.96 | 0.96 | 0.96 | 0.94 | 0.94 | 0.93 | 0.93 | 0.93 | 0.93 | 0.94 | 0.95 | 0.95 |

Average = Sum(40)1…12 /12= | 0.94 | (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |

## 4. Water heating energy requirement: kWh/year:



Assumed occupancy, N | 2.97 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 104.81 | (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 115.29 | 111.1 | 106.91 | 102.72 | 98.52 | 94.33 | 94.33 | 98.52 | 102.72 | 106.91 | 111.1 | 115.29 |

Total = Sum(44)1…12 = | 1257.76 | (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 170.98 | 149.54 | 154.31 | 134.53 | 129.09 | 111.39 | 103.22 | 118.45 | 119.86 | 139.69 | 152.48 | 165.58 |

Total = Sum(45)1…12 = | 1649.12 | (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.65 | 22.43 | 23.15 | 20.18 | 19.36 | 16.71 | 15.48 | 17.77 | 17.98 | 20.95 | 22.87 | 24.84 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel | 1 | (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): | 0 | (48)

Temperature factor from Table 2b | 0 | (49)

Energy lost from water storage, kWh/year (48) x (49) = | 1 | (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.03 | (51)

If community heating see section 4.3

Volume factor from Table 2a | 4.93 | (52)

Temperature factor from Table 2b | 0.6 | (53)

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| | | | |
|---|---|---|---|
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0.1 | (54) |
| Enter (50) or (54) in (55) | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 — 0 — (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 197.27 | 173.29 | 180.6 | 159.98 | 155.38 | 136.84 | 129.51 | 144.74 | 145.31 | 165.98 | 177.92 | 191.88 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 197.27 | 173.29 | 180.6 | 159.98 | 155.38 | 136.84 | 129.51 | 144.74 | 145.31 | 165.98 | 177.92 | 191.88 | |

Output from water heater (annual)$_{1…12}$ — 1958.69 — (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 75.46 | 66.53 | 69.92 | 62.74 | 61.53 | 55.05 | 52.93 | 57.99 | 57.86 | 65.06 | 68.71 | 73.67 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating



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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 77.92 | 69.21 | 56.29 | 42.61 | 31.85 | 26.89 | 29.06 | 37.77 | 50.69 | 64.37 | 75.13 | 80.09 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 521.83 | 527.24 | 513.6 | 484.55 | 447.88 | 413.41 | 390.39 | 384.97 | 398.62 | 427.67 | 464.34 | 498.8 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 101.43 | 99 | 93.98 | 87.14 | 82.7 | 76.45 | 71.14 | 77.95 | 80.37 | 87.44 | 95.43 | 99.01 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 816.45 | 810.73 | 779.13 | 729.57 | 677.71 | 632.03 | 605.86 | 615.97 | 644.95 | 694.75 | 750.17 | 793.18 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

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| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 0.97 | x | 10.63 | x | 0.9 | x | 0.9 | = | 37.6 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 10.63 | x | 0.9 | x | 0.9 | = | 18.37 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 10.63 | x | 0.9 | x | 0.9 | = | 21.7 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 20.32 | x | 0.9 | x | 0.9 | = | 71.85 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 20.32 | x | 0.9 | x | 0.9 | = | 35.11 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 20.32 | x | 0.9 | x | 0.9 | = | 41.48 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 34.53 | x | 0.9 | x | 0.9 | = | 122.09 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 34.53 | x | 0.9 | x | 0.9 | = | 59.66 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 34.53 | x | 0.9 | x | 0.9 | = | 70.48 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 55.46 | x | 0.9 | x | 0.9 | = | 196.1 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 55.46 | x | 0.9 | x | 0.9 | = | 95.83 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 55.46 | x | 0.9 | x | 0.9 | = | 113.21 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 74.72 | x | 0.9 | x | 0.9 | = | 264.17 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 74.72 | x | 0.9 | x | 0.9 | = | 129.09 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 74.72 | x | 0.9 | x | 0.9 | = | 152.51 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 79.99 | x | 0.9 | x | 0.9 | = | 282.8 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 79.99 | x | 0.9 | x | 0.9 | = | 138.19 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 79.99 | x | 0.9 | x | 0.9 | = | 163.27 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 74.68 | x | 0.9 | x | 0.9 | = | 264.03 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 74.68 | x | 0.9 | x | 0.9 | = | 129.02 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 74.68 | x | 0.9 | x | 0.9 | = | 152.43 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 59.25 | x | 0.9 | x | 0.9 | = | 209.47 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 59.25 | x | 0.9 | x | 0.9 | = | 102.36 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 59.25 | x | 0.9 | x | 0.9 | = | 120.93 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 41.52 | x | 0.9 | x | 0.9 | = | 146.79 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 41.52 | x | 0.9 | x | 0.9 | = | 71.73 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 41.52 | x | 0.9 | x | 0.9 | = | 84.74 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 24.19 | x | 0.9 | x | 0.9 | = | 85.53 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 24.19 | x | 0.9 | x | 0.9 | = | 41.79 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 24.19 | x | 0.9 | x | 0.9 | = | 49.38 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 13.12 | x | 0.9 | x | 0.9 | = | 46.38 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 13.12 | x | 0.9 | x | 0.9 | = | 22.66 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 13.12 | x | 0.9 | x | 0.9 | = | 26.78 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 8.86 | x | 0.9 | x | 0.9 | = | 31.34 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 8.86 | x | 0.9 | x | 0.9 | = | 15.32 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 8.86 | x | 0.9 | x | 0.9 | = | 18.09 | (74) |
| East | 0.9x | 2 | x | 2.8 | x | 19.64 | x | 0.9 | x | 0.9 | = | 80.18 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 19.64 | x | 0.9 | x | 0.9 | = | 71.59 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 38.42 | x | 0.9 | x | 0.9 | = | 156.85 | (76) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 2 | x | 2.5 | x | 38.42 | x | 0.9 | x | 0.9 | = | 140.04 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 63.27 | x | 0.9 | x | 0.9 | = | 258.31 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 63.27 | x | 0.9 | x | 0.9 | = | 230.63 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 92.28 | x | 0.9 | x | 0.9 | = | 376.72 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 92.28 | x | 0.9 | x | 0.9 | = | 336.36 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 113.09 | x | 0.9 | x | 0.9 | = | 461.69 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 113.09 | x | 0.9 | x | 0.9 | = | 412.22 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 115.77 | x | 0.9 | x | 0.9 | = | 472.62 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 115.77 | x | 0.9 | x | 0.9 | = | 421.98 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 110.22 | x | 0.9 | x | 0.9 | = | 449.95 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 110.22 | x | 0.9 | x | 0.9 | = | 401.75 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 94.68 | x | 0.9 | x | 0.9 | = | 386.5 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 94.68 | x | 0.9 | x | 0.9 | = | 345.09 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 73.59 | x | 0.9 | x | 0.9 | = | 300.42 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 73.59 | x | 0.9 | x | 0.9 | = | 268.23 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 45.59 | x | 0.9 | x | 0.9 | = | 186.11 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 45.59 | x | 0.9 | x | 0.9 | = | 166.17 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 24.49 | x | 0.9 | x | 0.9 | = | 99.97 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 24.49 | x | 0.9 | x | 0.9 | = | 89.26 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 16.15 | x | 0.9 | x | 0.9 | = | 65.94 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 16.15 | x | 0.9 | x | 0.9 | = | 58.87 | (76) |
| South | 0.9x | 1 | x | 0.91 | x | 46.75 | x | 0.9 | x | 0.9 | = | 62.03 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 46.75 | x | 0.9 | x | 0.9 | = | 53.17 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 46.75 | x | 0.9 | x | 0.9 | = | 190.86 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 76.57 | x | 0.9 | x | 0.9 | = | 101.59 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 76.57 | x | 0.9 | x | 0.9 | = | 87.08 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 76.57 | x | 0.9 | x | 0.9 | = | 312.58 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 97.53 | x | 0.9 | x | 0.9 | = | 129.41 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 97.53 | x | 0.9 | x | 0.9 | = | 110.92 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 97.53 | x | 0.9 | x | 0.9 | = | 398.17 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.23 | x | 0.9 | x | 0.9 | = | 146.26 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 110.23 | x | 0.9 | x | 0.9 | = | 125.36 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 110.23 | x | 0.9 | x | 0.9 | = | 450.02 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 114.87 | x | 0.9 | x | 0.9 | = | 152.41 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 114.87 | x | 0.9 | x | 0.9 | = | 130.64 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 114.87 | x | 0.9 | x | 0.9 | = | 468.95 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.55 | x | 0.9 | x | 0.9 | = | 146.67 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 110.55 | x | 0.9 | x | 0.9 | = | 125.72 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 110.55 | x | 0.9 | x | 0.9 | = | 451.3 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 108.01 | x | 0.9 | x | 0.9 | = | 143.31 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 108.01 | x | 0.9 | x | 0.9 | = | 122.84 | (78) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 2.8 | x | 108.01 | x | 0.9 | x | 0.9 | = | 440.95 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 104.89 | x | 0.9 | x | 0.9 | = | 139.17 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 104.89 | x | 0.9 | x | 0.9 | = | 119.29 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 104.89 | x | 0.9 | x | 0.9 | = | 428.22 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 101.89 | x | 0.9 | x | 0.9 | = | 135.18 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 101.89 | x | 0.9 | x | 0.9 | = | 115.87 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 101.89 | x | 0.9 | x | 0.9 | = | 415.94 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 82.59 | x | 0.9 | x | 0.9 | = | 109.57 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 82.59 | x | 0.9 | x | 0.9 | = | 93.92 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 82.59 | x | 0.9 | x | 0.9 | = | 337.15 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 55.42 | x | 0.9 | x | 0.9 | = | 73.53 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 55.42 | x | 0.9 | x | 0.9 | = | 63.02 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 55.42 | x | 0.9 | x | 0.9 | = | 226.23 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 40.4 | x | 0.9 | x | 0.9 | = | 53.6 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 40.4 | x | 0.9 | x | 0.9 | = | 45.94 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 40.4 | x | 0.9 | x | 0.9 | = | 164.92 | (78) |



Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 535.5 | 946.57 | 1379.66 | 1839.87 | 2171.67 | 2202.56 | 2104.27 | 1851.05 | 1538.9 | 1069.62 | 647.84 | 454.02 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1351.95 | 1757.3 | 2158.8 | 2569.44 | 2849.38 | 2834.59 | 2710.14 | 2467.02 | 2183.86 | 1764.37 | 1398.01 | 1247.2 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) — 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 0.99 | 0.97 | 0.9 | 0.74 | 0.54 | 0.37 | 0.27 | 0.31 | 0.52 | 0.85 | 0.98 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 20.17 | 20.43 | 20.72 | 20.93 | 20.99 | 21 | 21 | 21 | 20.99 | 20.87 | 20.47 | 20.12 | (87) |

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

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

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.99 | 0.96 | 0.88 | 0.7 | 0.49 | 0.32 | 0.22 | 0.25 | 0.46 | 0.81 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 19.02 | 19.4 | 19.79 | 20.06 | 20.12 | 20.14 | 20.14 | 20.14 | 20.13 | 20 | 19.46 | 18.96 | (90) |

fLA = Living area ÷ (4) = 0.42 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.5 | 19.83 | 20.18 | 20.42 | 20.49 | 20.5 | 20.5 | 20.5 | 20.49 | 20.36 | 19.88 | 19.44 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.5 | 19.83 | 20.18 | 20.42 | 20.49 | 20.5 | 20.5 | 20.5 | 20.49 | 20.36 | 19.88 | 19.44 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

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

# SAP WorkSheet: New dwelling design stage

Utilisation factor for gains, hm:

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (94)m= | 0.99 | 0.96 | 0.88 | 0.71 | 0.51 | 0.34 | 0.24 | 0.27 | 0.48 | 0.82 | 0.97 | 0.99 | (94) |

Useful gains, hmGm , W = (94)m x (84)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (95)m= | 1337.35 | 1689.36 | 1908.36 | 1831.1 | 1457.85 | 976.35 | 646.14 | 677.85 | 1056.32 | 1448.83 | 1357.43 | 1238.1 | (95) |

Monthly average external temperature from Table 8

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (97)m= | 2601.75 | 2547.71 | 2327.81 | 1935.45 | 1472.3 | 977.46 | 646.23 | 678.06 | 1063.92 | 1635.75 | 2152.59 | 2580.67 | (97) |

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (98)m= | 940.71 | 576.81 | 312.07 | 75.13 | 10.75 | 0 | 0 | 0 | 0 | 139.07 | 572.51 | 998.87 |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3625.93 (98)

Space heating requirement in kWh/m²/year 20.37 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1557.3 | 1225.96 | 1256.41 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.99 | 1 | 0.99 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1537.4 | 1220.07 | 1245.44 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 2834.59 | 2710.14 | 2467.02 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 933.98 | 1108.61 | 908.85 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 2951.44 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 233.49 | 277.15 | 227.21 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 737.86 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 4.15 (108)

## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none 0 (301)

Fraction of space heat from community system 1 – (301) = 1 (302)

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

Fraction of heat from Community boilers 1 (303a)

Fraction of total space heat from Community boilers (302) x (303a) = 1 (304a)

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| | | | |
|---|---|---|---|
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 3625.93 | |
| Space heat from Community boilers | (98) x (304a) x (305) x (306) = | 3807.23 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1958.69 | |
| If DHW from community scheme: | | | |
| Water heat from Community boilers | (64) x (303a) x (305) x (306) = | 2056.62 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 58.64 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 218.63 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f): | | | |
| mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 550.46 | (332) |

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## 10b. Fuel costs – Community heating scheme

| | **Fuel** kWh/year | **Fuel Price** (Table 12) | | **Fuel Cost** £/year | |
|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | 4.24 | x 0.01 = | 161.43 | (340a) |
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 87.2 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 28.84 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 72.61 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 470.07 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 0.89 | (357) |
| **SAP rating (section12)** | | 87.65 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | **Energy** kWh/year | **Emission factor** kg CO2/kWh | **Emissions** kg CO2/year |
|---|---|---|---|

# SAP WorkSheet: New dwelling design stage

| | | | | | |
|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP)<br>Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | 95 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | 0 | = | 1333.25 | (367) |
| Electrical energy for heat distribution | [(313) x | 0.52 | = | 30.43 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | = | 1363.69 | (373) |
| CO2 associated with space heating (secondary) | (309) x | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | 1363.69 | (376) |
| CO2 associated with space cooling | (315) x | 0.52 | = | 113.47 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | 0.52 | = | 285.69 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | 1762.84 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | 9.9 | (384) |
| **EI rating (section 14)** | | | | 89.41 | (385) |

## 13b. Primary Energy – Community heating scheme



| | | **Energy kWh/year** | **Primary factor** | **P.Energy kWh/year** | |
|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP)<br>Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | 95 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | 0 | = | 7530.42 | (367) |
| Electrical energy for heat distribution | [(313) x | | = | 180.02 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | = | 7710.44 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | 7710.44 | (373) |
| Energy associated with space heating (secondary) | (309) x | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | 7710.44 | (376) |
| Energy associated with space cooling | (315) x | 3.07 | = | 671.18 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | 3.07 | = | 1689.9 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | 10071.52 | (383) |

# SAP WorkSheet: New dwelling design stage

## User Details:

**Assessor Name:**

**Stroma Number:**

**Software Name:** Stroma FSAP 2012

**Software Version:** Version: 1.0.3.11

## Property Address: Flat 5

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 151 | (1a) x | 2.9 | (2a) = | 437.9 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 151 | (4) | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 437.9 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 5 | x 10 = | 50 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |



| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 50 | ÷ (5) = | 0.11 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |

*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*

| | | | |
|---|---|---|---|
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.34 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.31 | (21) |

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

Wind Factor (22a)m = (22)m ÷ 4

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.4 | 0.39 | 0.38 | 0.35 | 0.34 | 0.3 | 0.3 | 0.29 | 0.31 | 0.34 | 0.35 | 0.37 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.58 | 0.58 | 0.57 | 0.56 | 0.56 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.58 | 0.58 | 0.57 | 0.56 | 0.56 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 0.91 | x1/[1/( 1.2 )+ 0.04] | | = | 1.04 | | | (27) |
| Windows Type 2 | | | 1.54 | x1/[1/( 1.2 )+ 0.04] | | = | 1.76 | | | (27) |
| Windows Type 3 | | | 0.96 | x1/[1/( 1.2 )+ 0.04] | | = | 1.1 | | | (27) |
| Windows Type 4 | | | 2.76 | x1/[1/( 1.2 )+ 0.04] | | = | 3.16 | | | (27) |
| Walls Type1 | 34.33 | 0 | 34.33 | x | 0.12 | = | 4.12 | | | (29) |
| Walls Type2 | 34.3 | 0 | 34.3 | x | 0.12 | = | 4.12 | | | (29) |
| Walls Type3 | 78.3 | 2.76 | 75.54 | x | 0.12 | = | 9.06 | | | (29) |
| Walls Type4 | 13.34 | 0 | 13.34 | x | 0.12 | = | 1.6 | | | (29) |
| Walls Type5 | 20.88 | 0 | 20.88 | x | 0.11 | = | 2.26 | | | (29) |
| Walls Type6 | 13.54 | 0 | 13.54 | x | 0.11 | = | 1.47 | | | (29) |
| Walls Type7 | 13.34 | 0 | 13.34 | x | 0.11 | = | 1.44 | | | (29) |
| Total area of elements, m² | | | 221.22 | | | | | | | (31) |

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 41.61 (33)

Heat capacity Cm = S(A x k ) ((28)…(30) + (32) + (32a)…(32e) = 0 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

Thermal bridges : S (L x Y) calculated using Appendix K 33.18 (36)

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*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 74.8 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 83.82 | 83.37 | 82.93 | 80.86 | 80.47 | 78.67 | 78.67 | 78.34 | 79.37 | 80.47 | 81.25 | 82.07 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 158.61 | 158.16 | 157.72 | 155.65 | 155.27 | 153.47 | 153.47 | 153.13 | 154.16 | 155.27 | 156.05 | 156.87 | |

Average = Sum(39)1…12 /12= 155.65 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.01 | 1.02 | 1.03 | 1.03 | 1.04 |

Average = Sum(40)1…12 /12= 1.03 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |

## 4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.94 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 103.92 (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

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

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 114.32 | 110.16 | 106 | 101.85 | 97.69 | 93.53 | 93.53 | 97.69 | 101.85 | 106 | 110.16 | 114.32 |

Total = Sum(44)1…12 = 1247.09 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 169.53 | 148.27 | 153 | 133.39 | 127.99 | 110.45 | 102.34 | 117.44 | 118.84 | 138.5 | 151.19 | 164.18 |

Total = Sum(45)1…12 = 1635.13 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.43 | 22.24 | 22.95 | 20.01 | 19.2 | 16.57 | 15.35 | 17.62 | 17.83 | 20.78 | 22.68 | 24.63 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 1 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter ‘0’ in (47)

Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): 0 (48)

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 1 (50)

b) If manufacturer’s declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 4.93 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.1 (54)

Enter (50) or (54) in (55) 0.1 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 195.82 | 172.02 | 179.29 | 158.83 | 154.28 | 135.89 | 128.64 | 143.73 | 144.29 | 164.79 | 176.63 | 190.47 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 195.82 | 172.02 | 179.29 | 158.83 | 154.28 | 135.89 | 128.64 | 143.73 | 144.29 | 164.79 | 176.63 | 190.47 | |

Output from water heater (annual)1…12 | 1944.7 | (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 74.98 | 66.11 | 69.48 | 62.36 | 61.17 | 54.73 | 52.64 | 57.66 | 57.53 | 64.66 | 68.28 | 73.2 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 76.65 | 68.08 | 55.37 | 41.92 | 31.33 | 26.45 | 28.58 | 37.15 | 49.87 | 63.32 | 73.9 | 78.78 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 480.01 | 484.99 | 472.44 | 445.72 | 411.99 | 380.29 | 359.11 | 354.12 | 366.68 | 393.4 | 427.13 | 458.83 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 100.78 | 98.38 | 93.39 | 86.61 | 82.21 | 76.02 | 70.75 | 77.5 | 79.9 | 86.91 | 94.83 | 98.39 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 771.71 | 765.72 | 735.47 | 688.52 | 639.8 | 597.02 | 572.71 | 583.04 | 610.71 | 657.89 | 710.13 | 750.27 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

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| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 1.54 | x | 10.63 | x | 0.9 | x | 0.9 | = | 35.81 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 10.63 | x | 0.9 | x | 0.9 | = | 14.88 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 20.32 | x | 0.9 | x | 0.9 | = | 68.44 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 20.32 | x | 0.9 | x | 0.9 | = | 28.44 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 34.53 | x | 0.9 | x | 0.9 | = | 116.3 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 34.53 | x | 0.9 | x | 0.9 | = | 48.33 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 55.46 | x | 0.9 | x | 0.9 | = | 186.8 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 55.46 | x | 0.9 | x | 0.9 | = | 77.63 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.72 | x | 0.9 | x | 0.9 | = | 251.64 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 74.72 | x | 0.9 | x | 0.9 | = | 104.58 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 79.99 | x | 0.9 | x | 0.9 | = | 269.39 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 79.99 | x | 0.9 | x | 0.9 | = | 111.95 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.68 | x | 0.9 | x | 0.9 | = | 251.51 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 74.68 | x | 0.9 | x | 0.9 | = | 104.52 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 59.25 | x | 0.9 | x | 0.9 | = | 199.54 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 59.25 | x | 0.9 | x | 0.9 | = | 82.93 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 41.52 | x | 0.9 | x | 0.9 | = | 139.83 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 41.52 | x | 0.9 | x | 0.9 | = | 58.11 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 24.19 | x | 0.9 | x | 0.9 | = | 81.47 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 24.19 | x | 0.9 | x | 0.9 | = | 33.86 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 13.12 | x | 0.9 | x | 0.9 | = | 44.18 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 13.12 | x | 0.9 | x | 0.9 | = | 18.36 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 8.86 | x | 0.9 | x | 0.9 | = | 29.86 | (74) |
| North | 0.9x | 1 | x | 0.96 | x | 8.86 | x | 0.9 | x | 0.9 | = | 12.41 | (74) |
| South | 0.9x | 1 | x | 0.91 | x | 46.75 | x | 0.9 | x | 0.9 | = | 155.07 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 76.57 | x | 0.9 | x | 0.9 | = | 253.97 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 97.53 | x | 0.9 | x | 0.9 | = | 323.51 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.23 | x | 0.9 | x | 0.9 | = | 365.64 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 114.87 | x | 0.9 | x | 0.9 | = | 381.02 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.55 | x | 0.9 | x | 0.9 | = | 366.68 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 108.01 | x | 0.9 | x | 0.9 | = | 358.27 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 104.89 | x | 0.9 | x | 0.9 | = | 347.93 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 101.89 | x | 0.9 | x | 0.9 | = | 337.95 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 82.59 | x | 0.9 | x | 0.9 | = | 273.93 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 55.42 | x | 0.9 | x | 0.9 | = | 183.82 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 40.4 | x | 0.9 | x | 0.9 | = | 134 | (78) |
| West | 0.9x | 1 | x | 2.76 | x | 19.64 | x | 0.9 | x | 0.9 | = | 39.52 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 38.42 | x | 0.9 | x | 0.9 | = | 77.3 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 63.27 | x | 0.9 | x | 0.9 | = | 127.31 | (80) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.9x | 1 | x | 2.76 | x | 92.28 | x | 0.9 | x | 0.9 | = | 185.67 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 113.09 | x | 0.9 | x | 0.9 | = | 227.55 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 115.77 | x | 0.9 | x | 0.9 | = | 232.93 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 110.22 | x | 0.9 | x | 0.9 | = | 221.76 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 94.68 | x | 0.9 | x | 0.9 | = | 190.49 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 73.59 | x | 0.9 | x | 0.9 | = | 148.06 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 45.59 | x | 0.9 | x | 0.9 | = | 91.73 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 24.49 | x | 0.9 | x | 0.9 | = | 49.27 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 16.15 | x | 0.9 | x | 0.9 | = | 32.5 | (80) |

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 245.29 | 428.16 | 615.45 | 815.75 | 964.79 | 980.96 | 936.07 | 820.89 | 683.95 | 480.99 | 295.63 | 208.76 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1016.99 | 1193.88 | 1350.92 | 1504.26 | 1604.59 | 1577.98 | 1508.77 | 1403.93 | 1294.66 | 1138.88 | 1005.76 | 959.03 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 0.99 | 0.98 | 0.92 | 0.8 | 0.6 | 0.44 | 0.5 | 0.75 | 0.95 | 0.99 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.96 | 20.14 | 20.39 | 20.69 | 20.9 | 20.98 | 21 | 21 | 20.94 | 20.66 | 20.26 | 19.93 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 20.04 | 20.04 | 20.05 | 20.06 | 20.06 | 20.07 | 20.07 | 20.07 | 20.07 | 20.06 | 20.06 | 20.05 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 1 | 0.99 | 0.97 | 0.9 | 0.74 | 0.52 | 0.35 | 0.4 | 0.68 | 0.93 | 0.99 | 1 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.66 | 18.92 | 19.28 | 19.7 | 19.96 | 20.06 | 20.07 | 20.07 | 20.02 | 19.68 | 19.1 | 18.63 | (90) |

fLA = Living area ÷ (4) = 0.33 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.09 | 19.32 | 19.64 | 20.03 | 20.27 | 20.36 | 20.38 | 20.38 | 20.33 | 20.01 | 19.48 | 19.06 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.09 | 19.32 | 19.64 | 20.03 | 20.27 | 20.36 | 20.38 | 20.38 | 20.33 | 20.01 | 19.48 | 19.06 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.99 | 0.99 | 0.96 | 0.9 | 0.76 | 0.55 | 0.38 | 0.43 | 0.7 | 0.93 | 0.99 | 1 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1010.7 | 1176.56 | 1301.84 | 1352.13 | 1215.68 | 868.68 | 577.77 | 605.56 | 904.91 | 1059.23 | 992.09 | 954.58 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 2346.59 | 2280.68 | 2073.04 | 1731.98 | 1331.04 | 884.65 | 579.53 | 608.88 | 960.2 | 1460.32 | 1932.28 | 2331.13 | (97) |

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Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (98)m= | 993.91 | 741.97 | 573.77 | 273.49 | 85.82 | 0 | 0 | 0 | 0 | 298.41 | 676.94 | 1024.16 | |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4668.47 (98)

Space heating requirement in kWh/m²/year 30.92 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1442.6 | 1135.66 | 1163.82 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.88 | 0.94 | 0.91 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1273.45 | 1067.05 | 1064.85 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 1577.98 | 1508.77 | 1403.93 | 0 | 0 | 0 | 0 | (103) |

*Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m*
set (104)m to zero if (104)m < 3 × (98)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (104)m= | 0 | 0 | 0 | 0 | 0 | 219.26 | 328.64 | 252.28 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 800.18 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 | |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 54.82 | 82.16 | 63.07 | 0 | 0 | 0 | 0 | |

Total = Sum(107)$_{6...8}$ = 200.05 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 1.32 (108)



## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none 0 (301)

Fraction of space heat from community system 1 – (301) = 1 (302)

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

Fraction of heat from Community boilers 1 (303a)

Fraction of total space heat from Community boilers (302) x (303a) = 1 (304a)

Factor for control and charging method (Table 4c(3)) for community heating system 1 (305)

Distribution loss factor (Table 12c) for community heating system 1.05 (306)

| **Space heating** | | **kWh/year** | |
|---|---|---|---|
| Annual space heating requirement | | 4668.47 | |
| Space heat from Community boilers | (98) x (304a) x (305) x (306) = | 4901.89 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |

# SAP WorkSheet: New dwelling design stage

**Water heating**

| | | | |
|---|---|---|---|
| Annual water heating requirement | | 1944.7 | |
| If DHW from community scheme:<br>Water heat from Community boilers | (64) x (303a) x (305) x (306) = | 2041.93 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 69.44 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 59.27 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f):<br>mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 541.48 | (332) |

## 10b. Fuel costs – Community heating scheme

| | **Fuel** kWh/year | | **Fuel Price** (Table 12) | | **Fuel Cost** £/year | |
|---|---|---|---|---|---|---|
| Space heating from CHP | (307a) | x | 4.24 | x 0.01 = | 207.84 | (340a) |
| Water heating from CHP | (310a) | x | 4.24 | x 0.01 = | 86.58 | (342a) |
| | | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | | 13.19 | x 0.01 = | 7.82 | (348) |
| Pumps and fans | (331) | | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | | 13.19 | x 0.01 = | 71.42 | (350) |
| Additional standing charges (Table 12) | | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | | 493.66 | (355) |



## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 1.06 | (357) |
| **SAP rating (section12)** | | 85.24 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | **Energy** kWh/year | **Emission factor** kg CO2/kWh | **Emissions** kg CO2/year | |
|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP)<br>Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | 95 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 = | 1578.81 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 = | 36.04 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | = | 1614.84 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 = | 0 | (375) |

| | | | | | |
|---|---|---|---|---|---|
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | 1614.84 | (376) |
| CO2 associated with space cooling | (315) x | 0.52 | = | 30.76 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | 0.52 | = | 281.03 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | 1926.64 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | 12.76 | (384) |
| **EI rating (section 14)** | | | | 86.83 | (385) |

## 13b. Primary Energy – Community heating scheme

| | | Energy kWh/year | Primary factor | | P.Energy kWh/year | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 8917.33 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 213.18 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 9130.5 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 9130.5 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | | 9130.5 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = | 181.97 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = | 1662.35 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | | 10974.82 | (383) |

# SAP WorkSheet: New dwelling design stage

User Details:

**Assessor Name:** | **Stroma Number:**
**Software Name:** Stroma FSAP 2012 | **Software Version:** Version: 1.0.3.11

Property Address: Flat 6

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 167 | (1a) x | 2.9 | (2a) = | 484.3 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 167 | (4) | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 484.3 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 4 | x 10 = | 40 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

DRAFT

| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 40 | ÷ (5) = | 0.08 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |

*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*

| | | | |
|---|---|---|---|
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.31 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.28 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |
| Wind Factor (22a)m = (22)m ÷ 4 | | | | | | | | | | | | |
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

# SAP WorkSheet: New dwelling design stage

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.36 | 0.36 | 0.35 | 0.31 | 0.31 | 0.27 | 0.27 | 0.26 | 0.28 | 0.31 | 0.32 | 0.33 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.57 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.56 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.57 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.56 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 3.43 | x1/[1/( 1.2 )+ 0.04] | | = | 3.93 | | | (27) |
| Windows Type 2 | | | 1.54 | x1/[1/( 1.2 )+ 0.04] | | = | 1.76 | | | (27) |
| Windows Type 3 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 4 | | | 0.91 | x1/[1/( 1.2 )+ 0.04] | | = | 1.04 | | | (27) |
| Windows Type 5 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 6 | | | 1.26 | x1/[1/( 1.2 )+ 0.04] | | = | 1.44 | | | (27) |
| Windows Type 7 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Walls Type1 | 28.13 | 0 | 28.13 | x | 0.12 | = | 3.38 | | | (29) |
| Walls Type2 | 63.8 | 4.9 | 58.9 | x | 0.12 | = | 7.07 | | | (29) |
| Walls Type3 | 21.46 | 0 | 21.46 | x | 0.11 | = | 2.32 | | | (29) |
| Walls Type4 | 28.13 | 0 | 28.13 | x | 0.12 | = | 3.38 | | | (29) |
| Roof | 72 | 0 | 72 | x | 0.18 | = | 12.96 | | | (30) |
| Total area of elements, m² | | | 237.46 | | | | | | | (31) |

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 61.4 (33)

Heat capacity Cm = S(A x k ) ((28)…(30) + (32) + (32a)…(32e) = 648 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f*

*can be used instead of a detailed calculation.*

| | | |
|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | 35.62 | (36) |

*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 97.02 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 90.43 | 90.02 | 89.62 | 87.74 | 87.39 | 85.75 | 85.75 | 85.44 | 86.38 | 87.39 | 88.1 | 88.84 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 187.45 | 187.04 | 186.64 | 184.76 | 184.41 | 182.77 | 182.77 | 182.47 | 183.4 | 184.41 | 185.12 | 185.86 | |

Average = $Sum(39)_{1...12}$ /12= 184.76 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.12 | 1.12 | 1.12 | 1.11 | 1.1 | 1.09 | 1.09 | 1.09 | 1.1 | 1.1 | 1.11 | 1.11 | |

Average = $Sum(40)_{1...12}$ /12= 1.11 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |

## 4. Water heating energy requirement: kWh/year:



Assumed occupancy, N 2.96 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 104.47 (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 114.91 | 110.73 | 106.55 | 102.38 | 98.2 | 94.02 | 94.02 | 98.2 | 102.38 | 106.55 | 110.73 | 114.91 |

Total = $Sum(44)_{1...12}$ = 1253.58 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 170.41 | 149.04 | 153.8 | 134.09 | 128.66 | 111.02 | 102.88 | 118.05 | 119.46 | 139.22 | 151.97 | 165.03 |

Total = $Sum(45)_{1...12}$ = 1643.65 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.56 | 22.36 | 23.07 | 20.11 | 19.3 | 16.65 | 15.43 | 17.71 | 17.92 | 20.88 | 22.8 | 24.76 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 1 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter ‘0’ in (47)

Water storage loss:

| | | | |
|---|---|---|---|
| a) If manufacturer’s declared loss factor is known (kWh/day): | | 0 | (48) |
| Temperature factor from Table 2b | | 0 | (49) |
| Energy lost from water storage, kWh/year | (48) x (49) = | 1 | (50) |
| b) If manufacturer’s declared cylinder loss factor is not known: | | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | | 0.03 | (51) |
| If community heating see section 4.3 | | | |
| Volume factor from Table 2a | | 4.93 | (52) |
| Temperature factor from Table 2b | | 0.6 | (53) |

# SAP WorkSheet: New dwelling design stage

| | | | |
|---|---|---|---|
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0.1 | (54) |
| Enter (50) or (54) in (55) | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 — 0 — (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 196.7 | 172.79 | 180.09 | 159.53 | 154.95 | 136.47 | 129.17 | 144.35 | 144.91 | 165.52 | 177.42 | 191.33 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 196.7 | 172.79 | 180.09 | 159.53 | 154.95 | 136.47 | 129.17 | 144.35 | 144.91 | 165.52 | 177.42 | 191.33 | |

Output from water heater (annual)$_{1...12}$ — 1953.22 — (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 75.27 | 66.37 | 69.75 | 62.59 | 61.39 | 54.92 | 52.82 | 57.86 | 57.73 | 64.9 | 68.54 | 73.48 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating



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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 75.44 | 67 | 54.49 | 41.25 | 30.84 | 26.03 | 28.13 | 36.57 | 49.08 | 62.32 | 72.73 | 77.54 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 505.19 | 510.43 | 497.22 | 469.1 | 433.6 | 400.23 | 377.94 | 372.7 | 385.91 | 414.03 | 449.53 | 482.9 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 101.17 | 98.76 | 93.75 | 86.93 | 82.51 | 76.28 | 70.99 | 77.77 | 80.18 | 87.23 | 95.2 | 98.77 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 796.68 | 791.08 | 760.34 | 712.17 | 661.83 | 617.43 | 591.94 | 601.92 | 630.05 | 678.46 | 732.34 | 774.08 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

# SAP WorkSheet: New dwelling design stage

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 1.54 | x | 10.63 | x | 0.9 | x | 0.9 | = | 35.81 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 10.63 | x | 0.9 | x | 0.9 | = | 29.3 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 10.63 | x | 0.9 | x | 0.9 | = | 65.11 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 20.32 | x | 0.9 | x | 0.9 | = | 68.44 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 20.32 | x | 0.9 | x | 0.9 | = | 56 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 20.32 | x | 0.9 | x | 0.9 | = | 124.44 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 34.53 | x | 0.9 | x | 0.9 | = | 116.3 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 34.53 | x | 0.9 | x | 0.9 | = | 95.15 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 34.53 | x | 0.9 | x | 0.9 | = | 211.45 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 55.46 | x | 0.9 | x | 0.9 | = | 186.8 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 55.46 | x | 0.9 | x | 0.9 | = | 152.84 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 55.46 | x | 0.9 | x | 0.9 | = | 339.64 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.72 | x | 0.9 | x | 0.9 | = | 251.64 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 74.72 | x | 0.9 | x | 0.9 | = | 205.89 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 74.72 | x | 0.9 | x | 0.9 | = | 457.53 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 79.99 | x | 0.9 | x | 0.9 | = | 269.39 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 79.99 | x | 0.9 | x | 0.9 | = | 220.41 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 79.99 | x | 0.9 | x | 0.9 | = | 489.8 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.68 | x | 0.9 | x | 0.9 | = | 251.51 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 74.68 | x | 0.9 | x | 0.9 | = | 205.78 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 74.68 | x | 0.9 | x | 0.9 | = | 457.29 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 59.25 | x | 0.9 | x | 0.9 | = | 199.54 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 59.25 | x | 0.9 | x | 0.9 | = | 163.26 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 59.25 | x | 0.9 | x | 0.9 | = | 362.8 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 41.52 | x | 0.9 | x | 0.9 | = | 139.83 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 41.52 | x | 0.9 | x | 0.9 | = | 114.4 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 41.52 | x | 0.9 | x | 0.9 | = | 254.23 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 24.19 | x | 0.9 | x | 0.9 | = | 81.47 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 24.19 | x | 0.9 | x | 0.9 | = | 66.66 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 24.19 | x | 0.9 | x | 0.9 | = | 148.13 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 13.12 | x | 0.9 | x | 0.9 | = | 44.18 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 13.12 | x | 0.9 | x | 0.9 | = | 36.15 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 13.12 | x | 0.9 | x | 0.9 | = | 80.33 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 8.86 | x | 0.9 | x | 0.9 | = | 29.86 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 8.86 | x | 0.9 | x | 0.9 | = | 24.43 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 8.86 | x | 0.9 | x | 0.9 | = | 54.28 | (74) |
| East | 0.9x | 1 | x | 2.8 | x | 19.64 | x | 0.9 | x | 0.9 | = | 40.09 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 38.42 | x | 0.9 | x | 0.9 | = | 78.42 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 63.27 | x | 0.9 | x | 0.9 | = | 129.15 | (76) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 1 | x | 2.8 | x | 92.28 | x | 0.9 | x | 0.9 | = | 188.36 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 113.09 | x | 0.9 | x | 0.9 | = | 230.84 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 115.77 | x | 0.9 | x | 0.9 | = | 236.31 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 110.22 | x | 0.9 | x | 0.9 | = | 224.98 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 94.68 | x | 0.9 | x | 0.9 | = | 193.25 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 73.59 | x | 0.9 | x | 0.9 | = | 150.21 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 45.59 | x | 0.9 | x | 0.9 | = | 93.06 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 24.49 | x | 0.9 | x | 0.9 | = | 49.99 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 16.15 | x | 0.9 | x | 0.9 | = | 32.97 | (76) |
| South | 0.9x | 1 | x | 3.43 | x | 46.75 | x | 0.9 | x | 0.9 | = | 116.9 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 46.75 | x | 0.9 | x | 0.9 | = | 31.01 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 46.75 | x | 0.9 | x | 0.9 | = | 95.43 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 76.57 | x | 0.9 | x | 0.9 | = | 191.46 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 76.57 | x | 0.9 | x | 0.9 | = | 50.79 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 76.57 | x | 0.9 | x | 0.9 | = | 156.29 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 97.53 | x | 0.9 | x | 0.9 | = | 243.88 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 97.53 | x | 0.9 | x | 0.9 | = | 64.7 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 97.53 | x | 0.9 | x | 0.9 | = | 199.09 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 110.23 | x | 0.9 | x | 0.9 | = | 275.64 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.23 | x | 0.9 | x | 0.9 | = | 73.13 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 110.23 | x | 0.9 | x | 0.9 | = | 225.01 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 114.87 | x | 0.9 | x | 0.9 | = | 287.23 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 114.87 | x | 0.9 | x | 0.9 | = | 76.2 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 114.87 | x | 0.9 | x | 0.9 | = | 234.47 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 110.55 | x | 0.9 | x | 0.9 | = | 276.42 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.55 | x | 0.9 | x | 0.9 | = | 73.34 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 110.55 | x | 0.9 | x | 0.9 | = | 225.65 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 108.01 | x | 0.9 | x | 0.9 | = | 270.08 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 108.01 | x | 0.9 | x | 0.9 | = | 71.65 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 108.01 | x | 0.9 | x | 0.9 | = | 220.47 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 104.89 | x | 0.9 | x | 0.9 | = | 262.29 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 104.89 | x | 0.9 | x | 0.9 | = | 69.59 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 104.89 | x | 0.9 | x | 0.9 | = | 214.11 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 101.89 | x | 0.9 | x | 0.9 | = | 254.76 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 101.89 | x | 0.9 | x | 0.9 | = | 67.59 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 101.89 | x | 0.9 | x | 0.9 | = | 207.97 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 82.59 | x | 0.9 | x | 0.9 | = | 206.5 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 82.59 | x | 0.9 | x | 0.9 | = | 54.79 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 82.59 | x | 0.9 | x | 0.9 | = | 168.57 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 55.42 | x | 0.9 | x | 0.9 | = | 138.57 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 55.42 | x | 0.9 | x | 0.9 | = | 36.76 | (78) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 2.8 | x | 55.42 | x | 0.9 | x | 0.9 | = | 113.12 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 40.4 | x | 0.9 | x | 0.9 | = | 101.01 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 40.4 | x | 0.9 | x | 0.9 | = | 26.8 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 40.4 | x | 0.9 | x | 0.9 | = | 82.46 | (78) |

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 413.67 | 725.84 | 1059.72 | 1441.42 | 1743.81 | 1791.32 | 1701.76 | 1464.84 | 1188.99 | 819.17 | 499.09 | 351.81 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1210.35 | 1516.91 | 1820.06 | 2153.59 | 2405.64 | 2408.75 | 2293.71 | 2066.75 | 1819.04 | 1497.64 | 1231.43 | 1125.89 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 0.99 | 0.95 | 0.85 | 0.67 | 0.48 | 0.35 | 0.4 | 0.66 | 0.92 | 0.99 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.91 | 20.14 | 20.45 | 20.77 | 20.95 | 20.99 | 21 | 21 | 20.96 | 20.7 | 20.23 | 19.87 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 19.98 | 19.98 | 19.99 | 20 | 20 | 20.01 | 20.01 | 20.01 | 20 | 20 | 19.99 | 19.99 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.99 | 0.98 | 0.94 | 0.82 | 0.61 | 0.41 | 0.27 | 0.32 | 0.58 | 0.89 | 0.98 | 1 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.54 | 18.88 | 19.32 | 19.75 | 19.95 | 20 | 20 | 20.01 | 19.98 | 19.67 | 19.02 | 18.49 | (90) |

fLA = Living area ÷ (4) = | 0.43 | (91)



Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.13 | 19.42 | 19.8 | 20.19 | 20.38 | 20.43 | 20.43 | 20.43 | 20.4 | 20.11 | 19.54 | 19.08 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.13 | 19.42 | 19.8 | 20.19 | 20.38 | 20.43 | 20.43 | 20.43 | 20.4 | 20.11 | 19.54 | 19.08 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.99 | 0.98 | 0.94 | 0.82 | 0.64 | 0.44 | 0.3 | 0.35 | 0.61 | 0.9 | 0.98 | 0.99 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1200.65 | 1482.28 | 1704.55 | 1776.13 | 1530.06 | 1056.52 | 699.32 | 733.51 | 1113.46 | 1343.16 | 1208.52 | 1119.4 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 2780.12 | 2716.11 | 2483.05 | 2086.37 | 1600.17 | 1064.88 | 700.31 | 735.63 | 1155.49 | 1753.67 | 2302.75 | 2765.46 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1175.13 | 829.13 | 579.21 | 223.37 | 52.16 | 0 | 0 | 0 | 0 | 305.42 | 787.84 | 1224.67 | |

Total per year (kWh/year) = Sum(98)$_{1…5,9…12}$ = | 5176.94 | (98)

Space heating requirement in kWh/m²/year | 31 | (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1718.02 | 1352.49 | 1386.74 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.94 | 0.97 | 0.96 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1622.23 | 1316.1 | 1325.18 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 2408.75 | 2293.71 | 2066.75 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 566.29 | 727.34 | 551.73 | 0 | 0 | 0 | 0 | |

Total = Sum(104) = 1845.37 (104)

Cooled fraction — f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 141.57 | 181.83 | 137.93 | 0 | 0 | 0 | 0 |

Total = Sum(107) = 461.34 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 2.76 (108)

## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community boilers | | 1 | (303a) |
| Fraction of total space heat from Community boilers | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 5176.94 | |
| Space heat from Community boilers | (98) x (304a) x (305) x (306) = | 5435.79 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1953.22 | |
| If DHW from community scheme: Water heat from Community boilers | (64) x (303a) x (305) x (306) = | 2050.88 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 74.87 | (313) |

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| | | | |
|---|---|---|---|
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 136.69 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 532.91 | (332) |

## 10b. Fuel costs – Community heating scheme

| | Fuel kWh/year | Fuel Price (Table 12) | | Fuel Cost £/year | |
|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | 4.24 | x 0.01 = | 230.48 | (340a) |
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 86.96 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 18.03 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 70.29 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 525.76 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 1.04 | (357) |
| **SAP rating (section12)** | | 85.47 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | Energy kWh/year | Emission factor kg CO2/kWh | | Emissions kg CO2/year | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1702.23 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 38.86 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1741.09 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1741.09 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 70.94 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 276.58 | (379) |

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| | | | |
|---|---|---|---|
| **Total CO2, kg/year** | sum of (376)…(382) = | 2088.61 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | 12.51 | (384) |
| **EI rating (section 14)** | | 86.8 | (385) |

## 13b. Primary Energy – Community heating scheme

| | | Energy kWh/year | Primary factor | | P.Energy kWh/year | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 9614.45 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 229.84 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 9844.29 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 9844.29 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | | 9844.29 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = | 419.65 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = | 1636.03 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | | 11899.97 | (383) |

# SAP WorkSheet: New dwelling design stage

## User Details:

**Assessor Name:** | **Stroma Number:**
**Software Name:** Stroma FSAP 2012 | **Software Version:** Version: 1.0.3.11

## Property Address: Flat 7

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | | Av. Height(m) | | | Volume(m³) | |
|---|---|---|---|---|---|---|---|---|
| Ground floor | 243 | (1a) | x | 2.9 | (2a) | = | 704.7 | (3a) |
| First floor | 28 | (1b) | x | 2.75 | (2b) | = | 77 | (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 271 | (4) | | | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) | | = | 781.7 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 5 | x 10 = | 50 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 50 | ÷ (5) = | 0.06 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |
| *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | | |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.29 | (18) |
| *Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used* | | | |
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.27 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

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Wind Factor (22a)m = (22)m ÷ 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.34 | 0.33 | 0.33 | 0.29 | 0.29 | 0.25 | 0.25 | 0.25 | 0.27 | 0.29 | 0.3 | 0.31 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.56 | 0.56 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.56 | 0.56 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (25) |



## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 0.98 | x1/[1/( 1.2 )+ 0.04] | | = | 1.12 | | | (27) |
| Windows Type 2 | | | 4 | x1/[1/( 1.2 )+ 0.04] | | = | 4.58 | | | (27) |
| Windows Type 3 | | | 3.3 | x1/[1/( 1.2 )+ 0.04] | | = | 3.78 | | | (27) |
| Windows Type 4 | | | 3.1 | x1/[1/( 1.2 )+ 0.04] | | = | 3.55 | | | (27) |
| Windows Type 5 | | | 2.1 | x1/[1/( 1.2 )+ 0.04] | | = | 2.4 | | | (27) |
| Windows Type 6 | | | 0.8 | x1/[1/( 1.2 )+ 0.04] | | = | 0.92 | | | (27) |
| Windows Type 7 | | | 1.54 | x1/[1/( 1.2 )+ 0.04] | | = | 1.76 | | | (27) |
| Rooflights | | | 1 | x1/[1/(1.3) + 0.04] | | = | 1.3 | | | (27b) |
| Walls Type1 | 44.77 | 6.28 | 38.49 | x | 0.12 | = | 4.62 | | | (29) |
| Walls Type2 | 69.02 | 2.1 | 66.92 | x | 0.12 | = | 8.03 | | | (29) |
| Walls Type3 | 45.53 | 8.5 | 37.03 | x | 0.12 | = | 4.44 | | | (29) |
| Walls Type4 | 13.34 | 0 | 13.34 | x | 0.11 | = | 1.44 | | | (29) |
| Walls Type5 | 21.46 | 2.94 | 18.52 | x | 0.11 | = | 2.01 | | | (29) |
| Walls Type6 | 69.02 | 4 | 65.02 | x | 0.12 | = | 7.8 | | | (29) |
| Walls Type7 | 9.86 | 0 | 9.86 | x | 0.11 | = | 1.07 | | | (29) |
| Roof Type1 | 28 | 2 | 26 | x | 0.18 | = | 4.68 | | | (30) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Roof Type2 | 87 | 2 | 85 | x 0.18 | = 15.3 | | | (30) |
| Total area of elements, m² | | | 386 | | | | | (31) |

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 78.42 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 0 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 57.9 | (36) |

*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 136.32 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 143.96 | 143.38 | 142.81 | 140.13 | 139.63 | 137.3 | 137.3 | 136.87 | 138.2 | 139.63 | 140.64 | 141.7 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 280.28 | 279.69 | 279.12 | 276.45 | 275.94 | 273.61 | 273.61 | 273.18 | 274.51 | 275.94 | 276.96 | 278.02 | |

Average = Sum(39)1…12 /12= 276.44 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.02 | 1.02 | 1.03 |

Average = Sum(40)1…12 /12= 1.02 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |



## 4. Water heating energy requirement: kWh/year:

| | | |
|---|---|---|
| Assumed occupancy, N | 3.09 | (42) |

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

| | | |
|---|---|---|
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 107.69 | (43) |

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 118.46 | 114.15 | 109.84 | 105.53 | 101.23 | 96.92 | 96.92 | 101.23 | 105.53 | 109.84 | 114.15 | 118.46 |

Total = Sum(44)1…12 = 1292.26 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 175.67 | 153.64 | 158.54 | 138.22 | 132.63 | 114.45 | 106.05 | 121.7 | 123.15 | 143.52 | 156.66 | 170.13 |

Total = Sum(45)1…12 = 1694.35 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 26.35 | 23.05 | 23.78 | 20.73 | 19.89 | 17.17 | 15.91 | 18.25 | 18.47 | 21.53 | 23.5 | 25.52 | (46) |

Water storage loss:

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 1 | (47) |

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter ‘0’ in (47)

Water storage loss:

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| | | | |
|---|---|---|---|
| a) If manufacturer's declared loss factor is known (kWh/day): | | 0 | (48) |
| Temperature factor from Table 2b | | 0 | (49) |
| Energy lost from water storage, kWh/year | (48) x (49) = | 1 | (50) |
| b) If manufacturer's declared cylinder loss factor is not known: | | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | | 0.03 | (51) |
| If community heating see section 4.3 | | | |
| Volume factor from Table 2a | | 4.93 | (52) |
| Temperature factor from Table 2b | | 0.6 | (53) |
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0.1 | (54) |
| Enter (50) or (54) in (55) | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |



Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 201.96 | 177.39 | 184.84 | 163.67 | 158.92 | 139.89 | 132.34 | 147.99 | 148.59 | 169.81 | 182.11 | 196.42 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 201.96 | 177.39 | 184.84 | 163.67 | 158.92 | 139.89 | 132.34 | 147.99 | 148.59 | 169.81 | 182.11 | 196.42 |

Output from water heater (annual)$_{1...12}$ | 2003.92 | (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 77.02 | 67.89 | 71.33 | 63.97 | 62.71 | 56.06 | 53.87 | 59.07 | 58.96 | 66.33 | 70.1 | 75.18 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 105.02 | 93.28 | 75.86 | 57.43 | 42.93 | 36.24 | 39.16 | 50.9 | 68.32 | 86.75 | 101.25 | 107.94 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 648.26 | 654.99 | 638.03 | 601.95 | 556.39 | 513.58 | 484.97 | 478.25 | 495.2 | 531.29 | 576.84 | 619.66 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 103.52 | 101.03 | 95.87 | 88.84 | 84.29 | 77.87 | 72.41 | 79.4 | 81.88 | 89.15 | 97.36 | 101.04 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 975.34 | 967.84 | 928.3 | 866.77 | 802.15 | 746.23 | 715.09 | 727.1 | 763.95 | 825.74 | 894 | 947.18 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 0.8 | x | 10.63 | x | 0.9 | x | 0.9 | = | 24.81 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 10.63 | x | 0.9 | x | 0.9 | = | 23.88 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 20.32 | x | 0.9 | x | 0.9 | = | 47.4 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 20.32 | x | 0.9 | x | 0.9 | = | 45.63 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 34.53 | x | 0.9 | x | 0.9 | = | 80.55 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 34.53 | x | 0.9 | x | 0.9 | = | 77.53 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 55.46 | x | 0.9 | x | 0.9 | = | 129.39 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 55.46 | x | 0.9 | x | 0.9 | = | 124.54 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 74.72 | x | 0.9 | x | 0.9 | = | 174.3 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.72 | x | 0.9 | x | 0.9 | = | 167.76 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 79.99 | x | 0.9 | x | 0.9 | = | 186.59 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 79.99 | x | 0.9 | x | 0.9 | = | 179.59 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 74.68 | x | 0.9 | x | 0.9 | = | 174.21 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.68 | x | 0.9 | x | 0.9 | = | 167.67 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 59.25 | x | 0.9 | x | 0.9 | = | 138.21 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 59.25 | x | 0.9 | x | 0.9 | = | 133.03 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 41.52 | x | 0.9 | x | 0.9 | = | 96.85 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 41.52 | x | 0.9 | x | 0.9 | = | 93.22 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 24.19 | x | 0.9 | x | 0.9 | = | 56.43 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 24.19 | x | 0.9 | x | 0.9 | = | 54.31 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 13.12 | x | 0.9 | x | 0.9 | = | 30.6 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 13.12 | x | 0.9 | x | 0.9 | = | 29.45 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 8.86 | x | 0.9 | x | 0.9 | = | 20.68 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 8.86 | x | 0.9 | x | 0.9 | = | 19.9 | (74) |
| East | 0.9x | 1 | x | 4 | x | 19.64 | x | 0.9 | x | 0.9 | = | 57.27 | (76) |
| East | 0.9x | 1 | x | 4 | x | 38.42 | x | 0.9 | x | 0.9 | = | 112.03 | (76) |
| East | 0.9x | 1 | x | 4 | x | 63.27 | x | 0.9 | x | 0.9 | = | 184.5 | (76) |
| East | 0.9x | 1 | x | 4 | x | 92.28 | x | 0.9 | x | 0.9 | = | 269.09 | (76) |
| East | 0.9x | 1 | x | 4 | x | 113.09 | x | 0.9 | x | 0.9 | = | 329.78 | (76) |
| East | 0.9x | 1 | x | 4 | x | 115.77 | x | 0.9 | x | 0.9 | = | 337.59 | (76) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 1 | x | 4 | x | 110.22 | x | 0.9 | x | 0.9 | = | 321.4 | (76) |
| East | 0.9x | 1 | x | 4 | x | 94.68 | x | 0.9 | x | 0.9 | = | 276.07 | (76) |
| East | 0.9x | 1 | x | 4 | x | 73.59 | x | 0.9 | x | 0.9 | = | 214.59 | (76) |
| East | 0.9x | 1 | x | 4 | x | 45.59 | x | 0.9 | x | 0.9 | = | 132.94 | (76) |
| East | 0.9x | 1 | x | 4 | x | 24.49 | x | 0.9 | x | 0.9 | = | 71.41 | (76) |
| East | 0.9x | 1 | x | 4 | x | 16.15 | x | 0.9 | x | 0.9 | = | 47.1 | (76) |
| South | 0.9x | 1 | x | 3.3 | x | 46.75 | x | 0.9 | x | 0.9 | = | 112.47 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 46.75 | x | 0.9 | x | 0.9 | = | 105.65 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 46.75 | x | 0.9 | x | 0.9 | = | 71.57 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 76.57 | x | 0.9 | x | 0.9 | = | 184.2 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 76.57 | x | 0.9 | x | 0.9 | = | 173.04 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 76.57 | x | 0.9 | x | 0.9 | = | 117.22 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 97.53 | x | 0.9 | x | 0.9 | = | 234.64 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 97.53 | x | 0.9 | x | 0.9 | = | 220.42 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 97.53 | x | 0.9 | x | 0.9 | = | 149.31 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 110.23 | x | 0.9 | x | 0.9 | = | 265.19 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 110.23 | x | 0.9 | x | 0.9 | = | 249.12 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 110.23 | x | 0.9 | x | 0.9 | = | 168.76 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 114.87 | x | 0.9 | x | 0.9 | = | 276.35 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 114.87 | x | 0.9 | x | 0.9 | = | 259.6 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 114.87 | x | 0.9 | x | 0.9 | = | 175.86 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 110.55 | x | 0.9 | x | 0.9 | = | 265.94 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 110.55 | x | 0.9 | x | 0.9 | = | 249.83 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 110.55 | x | 0.9 | x | 0.9 | = | 169.24 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 108.01 | x | 0.9 | x | 0.9 | = | 259.84 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 108.01 | x | 0.9 | x | 0.9 | = | 244.1 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 108.01 | x | 0.9 | x | 0.9 | = | 165.36 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 104.89 | x | 0.9 | x | 0.9 | = | 252.34 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 104.89 | x | 0.9 | x | 0.9 | = | 237.05 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 104.89 | x | 0.9 | x | 0.9 | = | 160.58 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 101.89 | x | 0.9 | x | 0.9 | = | 245.11 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 101.89 | x | 0.9 | x | 0.9 | = | 230.25 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 101.89 | x | 0.9 | x | 0.9 | = | 155.98 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 82.59 | x | 0.9 | x | 0.9 | = | 198.68 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 82.59 | x | 0.9 | x | 0.9 | = | 186.64 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 82.59 | x | 0.9 | x | 0.9 | = | 126.43 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 55.42 | x | 0.9 | x | 0.9 | = | 133.32 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 55.42 | x | 0.9 | x | 0.9 | = | 125.24 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 55.42 | x | 0.9 | x | 0.9 | = | 84.84 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 40.4 | x | 0.9 | x | 0.9 | = | 97.19 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 40.4 | x | 0.9 | x | 0.9 | = | 91.3 | (78) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 2.1 | x | 40.4 | x | 0.9 | x | 0.9 | = | 61.85 | (78) |
| West | 0.9x | 1 | x | 0.98 | x | 19.64 | x | 0.9 | x | 0.9 | = | 42.09 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 38.42 | x | 0.9 | x | 0.9 | = | 82.35 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 63.27 | x | 0.9 | x | 0.9 | = | 135.61 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 92.28 | x | 0.9 | x | 0.9 | = | 197.78 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 113.09 | x | 0.9 | x | 0.9 | = | 242.39 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 115.77 | x | 0.9 | x | 0.9 | = | 248.13 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 110.22 | x | 0.9 | x | 0.9 | = | 236.23 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 94.68 | x | 0.9 | x | 0.9 | = | 202.91 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 73.59 | x | 0.9 | x | 0.9 | = | 157.72 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 45.59 | x | 0.9 | x | 0.9 | = | 97.71 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 24.49 | x | 0.9 | x | 0.9 | = | 52.49 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 16.15 | x | 0.9 | x | 0.9 | = | 34.62 | (80) |
| Rooflights | 0.9x | 1 | x | 1 | x | 26 | x | 0.7 | x | 0.7 | = | 22.93 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 54 | x | 0.7 | x | 0.7 | = | 47.63 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 96 | x | 0.7 | x | 0.7 | = | 84.67 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 150 | x | 0.7 | x | 0.7 | = | 132.3 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 192 | x | 0.7 | x | 0.7 | = | 169.34 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 200 | x | 0.7 | x | 0.7 | = | 176.4 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 189 | x | 0.7 | x | 0.7 | = | 166.7 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 157 | x | 0.7 | x | 0.7 | = | 138.47 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 115 | x | 0.7 | x | 0.7 | = | 101.43 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 66 | x | 0.7 | x | 0.7 | = | 58.21 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 33 | x | 0.7 | x | 0.7 | = | 29.11 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 21 | x | 0.7 | x | 0.7 | = | 18.52 | (82) |



Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 460.68 | 809.49 | 1167.24 | 1536.16 | 1795.37 | 1813.31 | 1735.49 | 1538.68 | 1295.14 | 911.34 | 556.45 | 391.14 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1436.02 | 1777.33 | 2095.54 | 2402.92 | 2597.52 | 2559.53 | 2450.58 | 2265.78 | 2059.09 | 1737.08 | 1450.45 | 1338.33 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 1 | 0.99 | 0.95 | 0.84 | 0.66 | 0.49 | 0.55 | 0.81 | 0.97 | 1 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.85 | 20.03 | 20.3 | 20.62 | 20.87 | 20.97 | 21 | 20.99 | 20.92 | 20.58 | 20.15 | 19.82 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 20.05 | 20.06 | 20.06 | 20.07 | 20.07 | 20.08 | 20.08 | 20.08 | 20.07 | 20.07 | 20.07 | 20.06 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 1 | 1 | 0.98 | 0.93 | 0.79 | 0.57 | 0.39 | 0.44 | 0.74 | 0.96 | 1 | 1 | (89) |

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

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.51 | 18.78 | 19.16 | 19.63 | 19.94 | 20.06 | 20.07 | 20.07 | 20.01 | 19.58 | 18.95 | 18.47 | (90) |

fLA = Living area ÷ (4) = 0.31 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 18.92 | 19.16 | 19.51 | 19.93 | 20.23 | 20.34 | 20.36 | 20.36 | 20.29 | 19.89 | 19.32 | 18.88 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 18.92 | 19.16 | 19.51 | 19.93 | 20.23 | 20.34 | 20.36 | 20.36 | 20.29 | 19.89 | 19.32 | 18.88 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 1 | 0.99 | 0.98 | 0.93 | 0.8 | 0.6 | 0.42 | 0.47 | 0.76 | 0.96 | 0.99 | 1 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1433.03 | 1765.59 | 2051.15 | 2230.62 | 2084.14 | 1529.63 | 1023.79 | 1072.08 | 1557.33 | 1666.89 | 1442.77 | 1336.4 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 4098.7 | 3989.52 | 3632.52 | 3050.16 | 2352.55 | 1571.01 | 1028.48 | 1081.17 | 1699.51 | 2563.31 | 3384.44 | 4082.45 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1983.26 | 1494.48 | 1176.54 | 590.07 | 199.7 | 0 | 0 | 0 | 0 | 666.93 | 1398 | 2043.06 | |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 9552.04 (98)

Space heating requirement in kWh/m²/year 35.25 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 2571.96 | 2024.73 | 2076.17 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.85 | 0.92 | 0.88 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 2176.1 | 1855.42 | 1832.83 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 2559.54 | 2450.58 | 2265.78 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 276.07 | 442.8 | 322.11 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 1040.99 (104)

Cooled fraction — f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 69.02 | 110.7 | 80.53 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 260.25 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 0.96 (108)

# SAP WorkSheet: New dwelling design stage

## 9b. Energy requirements – Community heating scheme

| | | | |
|---|---|---|---|
| This part is used for space heating, space cooling or water heating provided by a community scheme. Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community boilers | | 1 | (303a) |
| Fraction of total space heat from Community boilers | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 9552.04 | |
| Space heat from Community boilers | (98) x (304a) x (305) x (306) = | 10029.65 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 2003.92 | |
| If DHW from community scheme: Water heat from Community boilers | (64) x (303a) x (305) x (306) = | 2104.12 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 121.34 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 77.11 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 741.87 | (332) |



## 10b. Fuel costs – Community heating scheme

| | **Fuel** kWh/year | **Fuel Price** (Table 12) | | **Fuel Cost** £/year | |
|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | 4.24 | x 0.01 = | 425.26 | (340a) |
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 89.21 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 10.17 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 97.85 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |

| | | | | | |
|---|---|---|---|---|---|
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 742.49 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | | | |
|---|---|---|---|---|---|
| Energy cost deflator (Table 12) | | | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | | | 0.99 | (357) |
| **SAP rating (section12)** | | | | 86.23 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | Energy kWh/year | Emission factor kg CO2/kWh | | Emissions kg CO2/year | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 2758.83 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 62.97 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 2821.81 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 2821.81 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 40.02 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 385.03 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | | 3246.86 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | | 11.98 | (384) |
| **EI rating (section 14)** | | | | | 86.23 | (385) |



## 13b. Primary Energy – Community heating scheme

| | | Energy kWh/year | Primary factor | | P.Energy kWh/year | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 15582.31 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 372.51 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 15954.81 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 15954.81 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | | 15954.81 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = | 236.73 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = | 2277.53 | (379) |

| | | | |
|---|---|---|---|
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | 18469.07 | (383) |

# SAP WorkSheet: New dwelling design stage

User Details:

**Assessor Name:** | **Stroma Number:**

**Software Name:** Stroma FSAP 2012 | **Software Version:** Version: 1.0.3.11

Property Address: Flat 8

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | | Av. Height(m) | | | Volume(m³) | |
|---|---|---|---|---|---|---|---|---|
| Ground floor | 19 | (1a) | x | 2.9 | (2a) | = | 55.1 | (3a) |
| First floor | 134 | (1b) | x | 2.9 | (2b) | = | 388.6 | (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 153 | (4) | | | | | | |
| Dwelling volume | | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) | = | 443.7 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 3 | x 10 = | 30 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

DRAFT

| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 30 | ÷ (5) = | 0.07 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |
| *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | | |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.29 | (18) |
| *Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used* | | | |
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.27 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

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Wind Factor (22a)m = (22)m ÷ 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.35 | 0.34 | 0.33 | 0.3 | 0.29 | 0.26 | 0.26 | 0.25 | 0.27 | 0.29 | 0.3 | 0.32 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.56 | 0.56 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.56 | 0.56 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 1.68 | x | 0.8 | = | 1.344 | | | (26) |
| Windows Type 1 | | | 3.43 | x1/[1/( 1.2 )+ 0.04] | | = | 3.93 | | | (27) |
| Windows Type 2 | | | 3.3 | x1/[1/( 1.2 )+ 0.04] | | = | 3.78 | | | (27) |
| Windows Type 3 | | | 1.84 | x1/[1/( 1.2 )+ 0.04] | | = | 2.11 | | | (27) |
| Windows Type 4 | | | 1.4 | x1/[1/( 1.2 )+ 0.04] | | = | 1.6 | | | (27) |
| Rooflights Type 1 | | | 1 | x1/[1/(1.3) + 0.04] | | = | 1.3 | | | (27b) |
| Rooflights Type 2 | | | 1 | x1/[1/(1.3) + 0.04] | | = | 1.3 | | | (27b) |
| Walls Type1 | 36.7 | 0 | 36.7 | x | 0.12 | = | 4.4 | | | (29) |
| Walls Type2 | 9.57 | 0 | 9.57 | x | 0.12 | = | 1.15 | | | (29) |
| Walls Type3 | 36.77 | 0 | 36.77 | x | 0.12 | = | 4.41 | | | (29) |
| Walls Type4 | 53.36 | 1.68 | 51.68 | x | 0.12 | = | 6.2 | | | (29) |
| Walls Type5 | 98.6 | 0 | 98.6 | x | 0.12 | = | 11.83 | | | (29) |
| Walls Type6 | 53.36 | 0 | 53.36 | x | 0.12 | = | 6.4 | | | (29) |
| Walls Type7 | 9.57 | 4.2 | 5.37 | x | 0.12 | = | 0.64 | | | (29) |
| Walls Type8 | 9.86 | 0 | 9.86 | x | 0.12 | = | 1.18 | | | (29) |
| Roof | 147 | 7 | 140 | x | 0.12 | = | 16.8 | | | (30) |
| Total area of elements, m² | | | 466.79 | | | | | | | (31) |

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** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 81.57 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 0 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 70.02 | (36) |

*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 151.59 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 81.93 | 81.59 | 81.26 | 79.7 | 79.41 | 78.05 | 78.05 | 77.8 | 78.57 | 79.41 | 80 | 80.62 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 233.52 | 233.18 | 232.85 | 231.29 | 231 | 229.64 | 229.64 | 229.39 | 230.17 | 231 | 231.59 | 232.21 | |

Average = Sum(39)$_{1…12}$ /12= 231.29 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.53 | 1.52 | 1.52 | 1.51 | 1.51 | 1.5 | 1.5 | 1.5 | 1.5 | 1.51 | 1.51 | 1.52 | |

Average = Sum(40)$_{1…12}$ /12= 1.51 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |



## 4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.94 (42)
if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 104 (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | *Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)* | | | | | | | | | | | | |
| (44)m= | 114.4 | 110.24 | 106.08 | 101.92 | 97.76 | 93.6 | 93.6 | 97.76 | 101.92 | 106.08 | 110.24 | 114.4 | |

Total = Sum(44)$_{1…12}$ = 1247.95 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 169.65 | 148.37 | 153.11 | 133.48 | 128.08 | 110.52 | 102.42 | 117.52 | 118.93 | 138.6 | 151.29 | 164.29 | |

Total = Sum(45)$_{1…12}$ = 1636.26 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.45 | 22.26 | 22.97 | 20.02 | 19.21 | 16.58 | 15.36 | 17.63 | 17.84 | 20.79 | 22.69 | 24.64 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 1 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter ‘0’ in (47)
Water storage loss:

a) If manufacturer’s declared loss factor is known (kWh/day): 0 (48)

Temperature factor from Table 2b 0 (49)

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| | | | |
|---|---|---|---|
| Energy lost from water storage, kWh/year | (48) x (49) = | 1 | (50) |
| b) If manufacturer's declared cylinder loss factor is not known: | | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | | 0.03 | (51) |
| If community heating see section 4.3 | | | |
| Volume factor from Table 2a | | 4.93 | (52) |
| Temperature factor from Table 2b | | 0.6 | (53) |
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0.1 | (54) |
| Enter (50) or (54) in (55) | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3: 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 195.94 | 172.12 | 179.4 | 158.93 | 154.37 | 135.97 | 128.71 | 143.82 | 144.37 | 164.89 | 176.74 | 190.58 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 195.94 | 172.12 | 179.4 | 158.93 | 154.37 | 135.97 | 128.71 | 143.82 | 144.37 | 164.89 | 176.74 | 190.58 | |

Output from water heater (annual)1…12: 1945.83 (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 75.02 | 66.14 | 69.52 | 62.39 | 61.2 | 54.76 | 52.66 | 57.69 | 57.55 | 64.69 | 68.31 | 73.24 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| (67)m= | 72.19 | 64.12 | 52.15 | 39.48 | 29.51 | 24.91 | 26.92 | 34.99 | 46.97 | 59.64 | 69.6 | 74.2 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| (68)m= | 483.23 | 488.25 | 475.61 | 448.71 | 414.75 | 382.84 | 361.52 | 356.5 | 369.14 | 396.04 | 430 | 461.91 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| (69)m= | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | (69) |
| Pumps and fans gains (Table 5a) | | | | | | | | | | | | | |
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |
| Losses e.g. evaporation (negative values) (Table 5) | | | | | | | | | | | | | |
| (71)m= | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | (71) |

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Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 100.83 | 98.43 | 93.44 | 86.66 | 82.25 | 76.05 | 70.78 | 77.54 | 79.93 | 86.95 | 94.88 | 98.44 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 770.61 | 765.15 | 735.55 | 689.19 | 640.87 | 598.15 | 573.57 | 583.38 | 610.39 | 656.98 | 708.83 | 748.9 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 3.3 | x | 10.63 | x | 0.9 | x | 0.9 | = | 25.58 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 10.63 | x | 0.9 | x | 0.9 | = | 14.26 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 20.32 | x | 0.9 | x | 0.9 | = | 48.89 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 20.32 | x | 0.9 | x | 0.9 | = | 27.26 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 34.53 | x | 0.9 | x | 0.9 | = | 83.07 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 34.53 | x | 0.9 | x | 0.9 | = | 46.32 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 55.46 | x | 0.9 | x | 0.9 | = | 133.43 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 55.46 | x | 0.9 | x | 0.9 | = | 74.4 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 74.72 | x | 0.9 | x | 0.9 | = | 179.74 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 74.72 | x | 0.9 | x | 0.9 | = | 100.22 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 79.99 | x | 0.9 | x | 0.9 | = | 192.42 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 79.99 | x | 0.9 | x | 0.9 | = | 107.29 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 74.68 | x | 0.9 | x | 0.9 | = | 179.65 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 74.68 | x | 0.9 | x | 0.9 | = | 100.17 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 59.25 | x | 0.9 | x | 0.9 | = | 142.53 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 59.25 | x | 0.9 | x | 0.9 | = | 79.47 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 41.52 | x | 0.9 | x | 0.9 | = | 99.88 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 41.52 | x | 0.9 | x | 0.9 | = | 55.69 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 24.19 | x | 0.9 | x | 0.9 | = | 58.19 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 24.19 | x | 0.9 | x | 0.9 | = | 32.45 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 13.12 | x | 0.9 | x | 0.9 | = | 31.56 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 13.12 | x | 0.9 | x | 0.9 | = | 17.6 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 8.86 | x | 0.9 | x | 0.9 | = | 21.33 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 8.86 | x | 0.9 | x | 0.9 | = | 11.89 | (74) |
| East | 0.9x | 3 | x | 1.4 | x | 19.64 | x | 0.9 | x | 0.9 | = | 60.13 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 38.42 | x | 0.9 | x | 0.9 | = | 117.64 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 63.27 | x | 0.9 | x | 0.9 | = | 193.73 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 92.28 | x | 0.9 | x | 0.9 | = | 282.54 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 113.09 | x | 0.9 | x | 0.9 | = | 346.27 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 115.77 | x | 0.9 | x | 0.9 | = | 354.47 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 110.22 | x | 0.9 | x | 0.9 | = | 337.47 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 94.68 | x | 0.9 | x | 0.9 | = | 289.88 | (76) |

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 3 | x | 1.4 | x | 73.59 | x | 0.9 | x | 0.9 | = | 225.32 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 45.59 | x | 0.9 | x | 0.9 | = | 139.58 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 24.49 | x | 0.9 | x | 0.9 | = | 74.98 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 16.15 | x | 0.9 | x | 0.9 | = | 49.45 | (76) |
| South | 0.9x | 1 | x | 3.43 | x | 46.75 | x | 0.9 | x | 0.9 | = | 233.8 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 76.57 | x | 0.9 | x | 0.9 | = | 382.91 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 97.53 | x | 0.9 | x | 0.9 | = | 487.76 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 110.23 | x | 0.9 | x | 0.9 | = | 551.28 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 114.87 | x | 0.9 | x | 0.9 | = | 574.46 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 110.55 | x | 0.9 | x | 0.9 | = | 552.84 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 108.01 | x | 0.9 | x | 0.9 | = | 540.16 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 104.89 | x | 0.9 | x | 0.9 | = | 524.57 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 101.89 | x | 0.9 | x | 0.9 | = | 509.52 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 82.59 | x | 0.9 | x | 0.9 | = | 413.01 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 55.42 | x | 0.9 | x | 0.9 | = | 277.14 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 40.4 | x | 0.9 | x | 0.9 | = | 202.03 | (78) |
| Rooflights | 0.9x | 1 | x | 1 | x | 26 | x | 0.7 | x | 0.7 | = | 22.93 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 26 | x | 0.7 | x | 0.7 | = | 57.33 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 54 | x | 0.7 | x | 0.7 | = | 47.63 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 54 | x | 0.7 | x | 0.7 | = | 119.07 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 96 | x | 0.7 | x | 0.7 | = | 84.67 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 96 | x | 0.7 | x | 0.7 | = | 211.68 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 150 | x | 0.7 | x | 0.7 | = | 132.3 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 150 | x | 0.7 | x | 0.7 | = | 330.75 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 192 | x | 0.7 | x | 0.7 | = | 169.34 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 192 | x | 0.7 | x | 0.7 | = | 423.36 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 200 | x | 0.7 | x | 0.7 | = | 176.4 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 200 | x | 0.7 | x | 0.7 | = | 441 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 189 | x | 0.7 | x | 0.7 | = | 166.7 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 189 | x | 0.7 | x | 0.7 | = | 416.74 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 157 | x | 0.7 | x | 0.7 | = | 138.47 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 157 | x | 0.7 | x | 0.7 | = | 346.18 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 115 | x | 0.7 | x | 0.7 | = | 101.43 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 115 | x | 0.7 | x | 0.7 | = | 253.57 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 66 | x | 0.7 | x | 0.7 | = | 58.21 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 66 | x | 0.7 | x | 0.7 | = | 145.53 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 33 | x | 0.7 | x | 0.7 | = | 29.11 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 33 | x | 0.7 | x | 0.7 | = | 72.76 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 21 | x | 0.7 | x | 0.7 | = | 18.52 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 21 | x | 0.7 | x | 0.7 | = | 46.3 | (82) |



Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 414.04 | 743.39 | 1107.23 | 1504.7 | 1793.4 | 1824.42 | 1740.89 | 1521.11 | 1245.41 | 846.97 | 503.14 | 349.52 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1184.65 | 1508.53 | 1842.78 | 2193.89 | 2434.26 | 2422.57 | 2314.46 | 2104.49 | 1855.8 | 1503.95 | 1211.97 | 1098.42 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 0.99 | 0.98 | 0.96 | 0.89 | 0.75 | 0.57 | 0.43 | 0.49 | 0.74 | 0.94 | 0.99 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.44 | 19.7 | 20.07 | 20.51 | 20.81 | 20.95 | 20.99 | 20.98 | 20.87 | 20.43 | 19.84 | 19.38 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 19.67 | 19.67 | 19.67 | 19.68 | 19.68 | 19.69 | 19.69 | 19.69 | 19.68 | 19.68 | 19.68 | 19.67 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.99 | 0.98 | 0.94 | 0.85 | 0.68 | 0.47 | 0.3 | 0.35 | 0.64 | 0.91 | 0.98 | 0.99 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 17.64 | 18.01 | 18.55 | 19.15 | 19.52 | 19.66 | 19.68 | 19.68 | 19.6 | 19.07 | 18.23 | 17.57 | (90) |

fLA = Living area ÷ (4) = | 0.39 | (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 18.34 | 18.67 | 19.15 | 19.68 | 20.03 | 20.17 | 20.2 | 20.19 | 20.1 | 19.6 | 18.86 | 18.28 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 18.34 | 18.67 | 19.15 | 19.68 | 20.03 | 20.17 | 20.2 | 20.19 | 20.1 | 19.6 | 18.86 | 18.28 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.99 | 0.97 | 0.94 | 0.85 | 0.7 | 0.51 | 0.35 | 0.41 | 0.67 | 0.91 | 0.98 | 0.99 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1172.12 | 1469.84 | 1728.43 | 1865.41 | 1701.14 | 1232.3 | 817.72 | 855.8 | 1244.16 | 1365.64 | 1186.37 | 1089.59 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 3279.31 | 3211.87 | 2945.76 | 2493.83 | 1923.44 | 1278.46 | 825.64 | 869.73 | 1380.15 | 2079.05 | 2722.9 | 3269.43 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1567.75 | 1170.64 | 905.69 | 452.46 | 165.39 | 0 | 0 | 0 | 0 | 530.78 | 1106.3 | 1621.8 | |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = | 7520.83 | (98)

Space heating requirement in kWh/m²/year | 49.16 | (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 2158.64 | 1699.35 | 1743.37 | 0 | 0 | 0 | 0 | (100) |

Utilisation factor for loss hm

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.85 | 0.91 | 0.87 | 0 | 0 | 0 | 0 | (101) |

Useful loss, hmLm (Watts) = (100)m x (101)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1827.77 | 1537.92 | 1518.51 | 0 | 0 | 0 | 0 | (102) |

Gains (solar gains calculated for applicable weather region, see Table 10)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (103)m= | 0 | 0 | 0 | 0 | 0 | 2422.57 | 2314.46 | 2104.49 | 0 | 0 | 0 | 0 | (103) |

*Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m*
set (104)m to zero if (104)m < 3 × (98)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (104)m= | 0 | 0 | 0 | 0 | 0 | 428.26 | 577.74 | 435.97 | 0 | 0 | 0 | 0 |

Total = Sum(104)$_{6...8}$ = 1441.97 (104)

Cooled fraction — f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 107.06 | 144.44 | 108.99 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 360.49 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 2.36 (108)

## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community boilers | | 1 | (303a) |
| Fraction of total space heat from Community boilers | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 7520.83 | |
| Space heat from Community boilers | (98) x (304a) x (305) x (306) = | 7896.87 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1945.83 | |
| If DHW from community scheme:<br>Water heat from Community boilers | (64) x (303a) x (305) x (306) = | 2043.12 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 99.4 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 106.81 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f):<br>mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |

| | | | |
|---|---|---|---|
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 509.99 | (332) |

## 10b. Fuel costs – Community heating scheme

| | Fuel kWh/year | Fuel Price (Table 12) | | Fuel Cost £/year | |
|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | 4.24 | x 0.01 = | 334.83 | (340a) |
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 86.63 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 14.09 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 67.27 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 622.81 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 1.32 | (357) |
| **SAP rating (section12)** | | 81.57 | (358) |

## 12b. $CO_2$ Emissions – Community heating scheme

| | | Energy kWh/year | Emission factor kg CO2/kWh | | Emissions kg CO2/year | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 95 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 2260.04 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 51.59 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 2311.63 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 2311.63 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 55.44 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 264.69 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | | 2631.75 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | | 17.2 | (384) |
| **EI rating (section 14)** | | | | | 82.19 | (385) |

## 13b. Primary Energy – Community heating scheme

| Energy kWh/year | Primary factor | P.Energy kWh/year |
|---|---|---|

# SAP WorkSheet: New dwelling design stage

| | | | | | |
|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | 95 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | 0 | = | 12765.04 | (367) |
| Electrical energy for heat distribution | [(313) x | | = | 305.16 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | = | 13070.2 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | 13070.2 | (373) |
| Energy associated with space heating (secondary) | (309) x | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | 13070.2 | (376) |
| Energy associated with space cooling | (315) x | 3.07 | = | 327.91 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | 3.07 | = | 1565.67 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | 14963.78 | (383) |

## 9.2. SAP Worksheets at BE GREEN stage

# Block Compliance WorkSheet: 28 Redington Road_Rev C

User Details

**Assessor Name:**
**Stroma Number:**
**Software Name:** Stroma FSAP
**Software Version:** Version: 1.0.3.11

Calculation Details

| Dwelling | DER | TER | DFEE | TFEE | TFA |
|---|---|---|---|---|---|
| Flat 1 | 11.3 | 24.43 | 47.6 | 58.7 | 144 |
| Flat 2 | 8.77 | 18.78 | 36.6 | 45.9 | 229 |
| Flat 3 | 7.97 | 17.74 | 34.7 | 46.1 | 243 |
| Flat 4 | 8.59 | 19.18 | 33.8 | 45.8 | 178 |
| Flat 5 | 10.69 | 22.77 | 43.8 | 53.7 | 151 |
| Flat 6 | 10.43 | 22.17 | 45.2 | 54.3 | 167 |
| Flat 7 | 9.76 | 20.22 | 46.1 | 53.4 | 271 |
| Flat 8 | 13.52 | 27.83 | 64.5 | 72.4 | 153 |

Calculation Summary

| | |
|---|---|
| Total Floor Area | 1536.00 |
| Average TER | 21.11 |
| Average DER | 9.88 |
| Average DFEE | 43.10 |
| Average TFEE | 52.76 |
| Compliance<br>% Improvement DER\|TER<br>% Improvement DFEE\|TFEE | Pass<br>53.2<br>18.31 |

# SAP WorkSheet: New dwelling design stage

User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | | **Stroma Number:** | |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.3.11 |

Property Address: Flat 1

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | | Av. Height(m) | | | Volume(m³) | |
|---|---|---|---|---|---|---|---|---|
| Basement | 75 | (1a) | x | 2.8 | (2a) | = | 210 | (3a) |
| Ground floor | 69 | (1b) | x | 3.1 | (2b) | = | 213.9 | (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 144 | (4) | | | | | | |
| Dwelling volume | | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) | = | 423.9 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 4 | x 10 = | 40 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

DRAFT

| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 40 | ÷ (5) = | 0.09 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |
| *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | | |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.32 | (18) |
| *Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used* | | | |
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.3 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

Wind Factor (22a)m = (22)m ÷ 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.38 | 0.37 | 0.36 | 0.32 | 0.32 | 0.28 | 0.28 | 0.27 | 0.3 | 0.32 | 0.33 | 0.35 |

*Calculate effective air change rate for the applicable case*

| | | |
|---|---|---|
| If mechanical ventilation: | 0 | (23a) |
| If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) | 0 | (23b) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = | 0 | (23c) |

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (25) |

## 3. Heat losses and heat loss parameter:

| **ELEMENT** | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 1.085 | x1/[1/( 1.2 )+ 0.04] | | = | 1.24 | | | (27) |
| Windows Type 2 | | | 1.02 | x1/[1/( 1.2 )+ 0.04] | | = | 1.17 | | | (27) |
| Floor | | | 75 | x | 0.12 | = | 9 | | | (28) |
| Walls Type1 | 14 | 2.1 | 11.9 | x | 0.12 | = | 1.43 | | | (29) |
| Walls Type2 | 30.8 | 0 | 30.8 | x | 0.11 | = | 3.42 | | | (29) |
| Walls Type3 | 20.44 | 0 | 20.44 | x | 0.11 | = | 2.27 | | | (29) |
| Walls Type4 | 33.6 | 14.74 | 18.86 | x | 0.12 | = | 2.26 | | | (29) |
| Walls Type5 | 8.4 | 0 | 8.4 | x | 0.11 | = | 0.91 | | | (29) |
| Walls Type6 | 8.4 | 0 | 8.4 | x | 0.11 | = | 0.91 | | | (29) |
| Walls Type7 | 5.88 | 0 | 5.88 | x | 0.11 | = | 0.65 | | | (29) |
| Walls Type8 | 12.9 | 0 | 12.9 | x | 0.12 | = | 1.55 | | | (29) |
| Walls Type9 | 17.36 | 0 | 17.36 | x | 0.11 | = | 1.88 | | | (29) |
| Walls Type10 | 24.8 | 0 | 24.8 | x | 0.12 | = | 2.98 | | | (29) |
| Walls Type11 | 30.69 | 0 | 30.69 | x | 0.11 | = | 3.32 | | | (29) |
| Walls Type12 | 30.69 | 0 | 30.69 | x | 0.13 | = | 3.99 | | | (29) |
| Total area of elements, m² | | | 312.96 | | | | | | | (31) |

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** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

| | | | | |
|---|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | | 53.12 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | | 0 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 46.94 | (36) |

*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 100.06 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 79.87 | 79.48 | 79.1 | 77.33 | 77 | 75.45 | 75.45 | 75.17 | 76.05 | 77 | 77.67 | 78.37 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 179.93 | 179.54 | 179.17 | 177.39 | 177.06 | 175.51 | 175.51 | 175.23 | 176.11 | 177.06 | 177.73 | 178.43 | |

Average = Sum(39)$_{1…12}$ /12= 177.39 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.25 | 1.25 | 1.24 | 1.23 | 1.23 | 1.22 | 1.22 | 1.22 | 1.22 | 1.23 | 1.23 | 1.24 | |

Average = Sum(40)$_{1…12}$ /12= 1.23 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |



## 4. Water heating energy requirement: kWh/year:

Assumed occupancy, N — 2.92 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 103.65 (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)* | | | | | | | | | | | | | |
| (44)m= | 114.02 | 109.87 | 105.73 | 101.58 | 97.43 | 93.29 | 93.29 | 97.43 | 101.58 | 105.73 | 109.87 | 114.02 | |

Total = Sum(44)$_{1…12}$ = 1243.84 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 169.09 | 147.88 | 152.6 | 133.04 | 127.66 | 110.16 | 102.08 | 117.14 | 118.54 | 138.14 | 150.79 | 163.75 | |

Total = Sum(45)$_{1…12}$ = 1630.87 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.36 | 22.18 | 22.89 | 19.96 | 19.15 | 16.52 | 15.31 | 17.57 | 17.78 | 20.72 | 22.62 | 24.56 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 1 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)
Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 0 (48)

Temperature factor from Table 2b — 0 (49)

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Energy lost from water storage, kWh/year (48) x (49) = 1 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 4.93 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.1 (54)

Enter (50) or (54) in (55) 0.1 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 195.38 | 171.63 | 178.9 | 158.49 | 153.95 | 135.6 | 128.37 | 143.43 | 143.98 | 164.43 | 176.24 | 190.04 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 195.38 | 171.63 | 178.9 | 158.49 | 153.95 | 135.6 | 128.37 | 143.43 | 143.98 | 164.43 | 176.24 | 190.04 |

Output from water heater (annual)1…12 1940.44 (64)

DRAFT

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 74.83 | 65.98 | 69.35 | 62.25 | 61.06 | 54.64 | 52.55 | 57.56 | 57.42 | 64.54 | 68.15 | 73.06 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | 175.46 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 73.13 | 64.95 | 52.82 | 39.99 | 29.89 | 25.24 | 27.27 | 35.45 | 47.58 | 60.41 | 70.5 | 75.16 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 468.53 | 473.39 | 461.14 | 435.06 | 402.13 | 371.19 | 350.52 | 345.65 | 357.91 | 383.99 | 416.91 | 447.86 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | 55.47 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | -116.97 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 100.58 | 98.18 | 93.21 | 86.45 | 82.06 | 75.89 | 70.63 | 77.36 | 79.75 | 86.75 | 94.65 | 98.19 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 756.2 | 750.49 | 721.13 | 675.46 | 628.05 | 586.27 | 562.38 | 572.42 | 599.19 | 645.1 | 696.03 | 735.17 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 1.09 | x | 46.75 | x | 0.9 | x | 0.9 | = | 258.85 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 46.75 | x | 0.9 | x | 0.9 | = | 243.35 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 76.57 | x | 0.9 | x | 0.9 | = | 423.94 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 76.57 | x | 0.9 | x | 0.9 | = | 398.54 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 97.53 | x | 0.9 | x | 0.9 | = | 540.02 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 97.53 | x | 0.9 | x | 0.9 | = | 507.67 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 110.23 | x | 0.9 | x | 0.9 | = | 610.34 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 110.23 | x | 0.9 | x | 0.9 | = | 573.78 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 114.87 | x | 0.9 | x | 0.9 | = | 636.01 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 114.87 | x | 0.9 | x | 0.9 | = | 597.91 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 110.55 | x | 0.9 | x | 0.9 | = | 612.08 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 110.55 | x | 0.9 | x | 0.9 | = | 575.41 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 108.01 | x | 0.9 | x | 0.9 | = | 598.04 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 108.01 | x | 0.9 | x | 0.9 | = | 562.21 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 104.89 | x | 0.9 | x | 0.9 | = | 580.78 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 104.89 | x | 0.9 | x | 0.9 | = | 545.98 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 101.89 | x | 0.9 | x | 0.9 | = | 564.12 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 101.89 | x | 0.9 | x | 0.9 | = | 530.32 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 82.59 | x | 0.9 | x | 0.9 | = | 457.26 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 82.59 | x | 0.9 | x | 0.9 | = | 429.86 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 55.42 | x | 0.9 | x | 0.9 | = | 306.83 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 55.42 | x | 0.9 | x | 0.9 | = | 288.45 | (78) |
| South | 0.9x | 1 | x | 1.09 | x | 40.4 | x | 0.9 | x | 0.9 | = | 223.67 | (78) |
| South | 0.9x | 1 | x | 1.02 | x | 40.4 | x | 0.9 | x | 0.9 | = | 210.27 | (78) |



Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 502.2 | 822.48 | 1047.69 | 1184.12 | 1233.92 | 1187.48 | 1160.24 | 1126.76 | 1094.44 | 887.12 | 595.28 | 433.95 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1258.4 | 1572.96 | 1768.82 | 1859.58 | 1861.97 | 1773.75 | 1722.62 | 1699.18 | 1693.63 | 1532.22 | 1291.31 | 1169.12 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 0.99 | 0.97 | 0.94 | 0.88 | 0.77 | 0.61 | 0.44 | 0.47 | 0.67 | 0.89 | 0.98 | 0.99 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.87 | 20.13 | 20.4 | 20.67 | 20.87 | 20.97 | 20.99 | 20.99 | 20.95 | 20.7 | 20.22 | 19.82 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 19.88 | 19.88 | 19.88 | 19.89 | 19.9 | 19.9 | 19.9 | 19.91 | 19.9 | 19.9 | 19.89 | 19.89 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.99 | 0.97 | 0.92 | 0.85 | 0.71 | 0.51 | 0.34 | 0.36 | 0.58 | 0.85 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.42 | 18.78 | 19.17 | 19.54 | 19.78 | 19.89 | 19.9 | 19.9 | 19.87 | 19.58 | 18.93 | 18.35 | (90) |

fLA = Living area ÷ (4) = 0.35 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 18.93 | 19.25 | 19.6 | 19.94 | 20.16 | 20.27 | 20.29 | 20.29 | 20.24 | 19.97 | 19.38 | 18.86 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 18.93 | 19.25 | 19.6 | 19.94 | 20.16 | 20.27 | 20.29 | 20.29 | 20.24 | 19.97 | 19.38 | 18.86 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a



| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.98 | 0.96 | 0.92 | 0.85 | 0.73 | 0.54 | 0.37 | 0.4 | 0.61 | 0.86 | 0.96 | 0.99 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1237.69 | 1509.38 | 1625.86 | 1574.83 | 1352.4 | 966.16 | 643.19 | 675.78 | 1032.66 | 1314.25 | 1245.56 | 1154.73 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 2631.82 | 2577.3 | 2347.23 | 1957.71 | 1497.58 | 994.32 | 646.88 | 680.85 | 1082.19 | 1659.25 | 2183.37 | 2616.43 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1037.23 | 717.65 | 536.7 | 275.67 | 108.02 | 0 | 0 | 0 | 0 | 256.68 | 675.22 | 1087.51 | |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4694.67 (98)

Space heating requirement in kWh/m²/year 32.6 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1649.84 | 1298.81 | 1331.74 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.86 | 0.92 | 0.91 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1412.38 | 1196.49 | 1213.73 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 1773.75 | 1722.62 | 1699.18 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 260.19 | 391.44 | 361.17 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 1012.8 (104)

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| | | | |
|---|---|---|---|
| Cooled fraction | f C = cooled area ÷ (4) = | 1 | (105) |

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

| | | | |
|---|---|---|---|
| | *Total = Sum(104)* $_{1...12}$ = | 0 | (106) |

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 65.05 | 97.86 | 90.29 | 0 | 0 | 0 | 0 |

| | | | |
|---|---|---|---|
| | Total = Sum(107) $_{1...12}$ = | 253.2 | (107) |
| Space cooling requirement in kWh/m²/year | (107) ÷ (4) = | 1.76 | (108) |

## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community heat pump | | 1 | (303a) |
| Fraction of total space heat from Community heat pump | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 4694.67 | |
| Space heat from Community heat pump | (98) x (304a) x (305) x (306) = | 4929.4 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1940.44 | |
| If DHW from community scheme: Water heat from Community heat pump | (64) x (303a) x (305) x (306) = | 2037.46 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 69.67 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 75.02 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 516.59 | (332) |



## 10b. Fuel costs – Community heating scheme

| | **Fuel** kWh/year | | **Fuel Price** (Table 12) | | **Fuel Cost** £/year | |
|---|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | | 4.24 | x 0.01 = | 209.01 | (340a) |

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| | | | | | |
|---|---|---|---|---|---|
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 86.39 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 9.9 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 68.14 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 493.43 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 1.1 | (357) |
| **SAP rating (section12)** | | 84.7 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | **Energy kWh/year** | **Emission factor kg CO2/kWh** | | **Emissions kg CO2/year** | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1033.09 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 36.16 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1069.24 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1069.24 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 38.94 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 268.11 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | | 1376.29 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | | 9.56 | (384) |
| **EI rating (section 14)** | | | | | 90.24 | (385) |

## 13b. Primary Energy – Community heating scheme

| | | **Energy kWh/year** | **Primary factor** | | **P.Energy kWh/year** | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 6110.93 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 213.88 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 6324.81 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 6324.81 | (373) |

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| | | | | | |
|---|---|---|---|---|---|
| Energy associated with space heating (secondary) | (309) x | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | 6324.81 | (376) |
| Energy associated with space cooling | (315) x | 3.07 | = | 230.32 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | 3.07 | = | 1585.92 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | 8141.06 | (383) |

# SAP WorkSheet: New dwelling design stage

## User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | | **Stroma Number:** | |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.3.11 |

## Property Address: Flat 2

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 229 | (1a) x | 3.1 | (2a) = | 709.9 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 229 | (4) | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 709.9 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 5 | x 10 = | 50 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

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| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 50 | ÷ (5) = | 0.07 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |
| *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | | |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.3 | (18) |
| *Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used* | | | |
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.27 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Monthly average wind speed from Table 7** | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |
| **Wind Factor (22a)m = (22)m ÷ 4** | | | | | | | | | | | | |
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

# SAP WorkSheet: New dwelling design stage

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.35 | 0.34 | 0.33 | 0.3 | 0.29 | 0.26 | 0.26 | 0.25 | 0.27 | 0.29 | 0.31 | 0.32 |

*Calculate effective air change rate for the applicable case*

| | | |
|---|---|---|
| If mechanical ventilation: | 0 | (23a) |
| If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) | 0 | (23b) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = | 0 | (23c) |

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.56 | 0.56 | 0.56 | 0.55 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (25) |

## 3. Heat losses and heat loss parameter:

| **ELEMENT** | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 0.9 | x1/[1/( 1.2 )+ 0.04] | | = | 1.03 | | | (27) |
| Windows Type 2 | | | 1.2 | x1/[1/( 1.2 )+ 0.04] | | = | 1.37 | | | (27) |
| Windows Type 3 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 4 | | | 1.2 | x1/[1/( 1.2 )+ 0.04] | | = | 1.37 | | | (27) |
| Walls Type1 | 33.17 | 8.1 | 25.07 | x | 0.12 | = | 3.01 | | | (29) |
| Walls Type2 | 48.36 | 0 | 48.36 | x | 0.11 | = | 5.24 | | | (29) |
| Walls Type3 | 28.52 | 0 | 28.52 | x | 0.12 | = | 3.42 | | | (29) |
| Walls Type4 | 63.24 | 4.9 | 58.34 | x | 0.12 | = | 7 | | | (29) |
| Walls Type5 | 14.26 | 0 | 14.26 | x | 0.11 | = | 1.54 | | | (29) |
| Total area of elements, m² | | | 187.55 | | | | | | | (31) |

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 34.37 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 0 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 28.13 | (36) |
| *if details of thermal bridging are not known (36) = 0.15 x (31)* | | | |
| Total fabric heat loss | (33) + (36) = | 62.51 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 131.35 | 130.8 | 130.26 | 127.72 | 127.24 | 125.03 | 125.03 | 124.62 | 125.88 | 127.24 | 128.2 | 129.21 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 193.86 | 193.31 | 192.77 | 190.22 | 189.75 | 187.54 | 187.54 | 187.12 | 188.39 | 189.75 | 190.71 | 191.72 | |

Average = Sum(39)$_{1...12}$ /12= 190.22 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 0.85 | 0.84 | 0.84 | 0.83 | 0.83 | 0.82 | 0.82 | 0.82 | 0.82 | 0.83 | 0.83 | 0.84 |

Average = Sum(40)$_{1...12}$ /12= 0.83 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |

## 4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 3.04 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 106.39 (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*



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

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 117.03 | 112.77 | 108.52 | 104.26 | 100.01 | 95.75 | 95.75 | 100.01 | 104.26 | 108.52 | 112.77 | 117.03 |

Total = Sum(44)$_{1...12}$ = 1276.69 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 173.55 | 151.79 | 156.63 | 136.56 | 131.03 | 113.07 | 104.77 | 120.23 | 121.67 | 141.79 | 154.78 | 168.08 |

Total = Sum(45)$_{1...12}$ = 1673.95 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 26.03 | 22.77 | 23.5 | 20.48 | 19.65 | 16.96 | 15.72 | 18.03 | 18.25 | 21.27 | 23.22 | 25.21 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 1 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0 (48)

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 1 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 4.93 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.1 (54)

Enter (50) or (54) in (55) 0.1 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 199.84 | 175.54 | 182.93 | 162 | 157.32 | 138.51 | 131.07 | 146.52 | 147.11 | 168.08 | 180.22 | 194.37 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 199.84 | 175.54 | 182.93 | 162 | 157.32 | 138.51 | 131.07 | 146.52 | 147.11 | 168.08 | 180.22 | 194.37 |

Output from water heater (annual)$_{1...12}$ — 1983.52 (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 76.32 | 67.28 | 70.69 | 63.41 | 62.18 | 55.6 | 53.45 | 58.59 | 58.46 | 65.76 | 69.47 | 74.5 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | 182.38 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 108.63 | 96.48 | 78.46 | 59.4 | 44.4 | 37.49 | 40.51 | 52.65 | 70.67 | 89.73 | 104.73 | 111.64 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 593.78 | 599.95 | 584.42 | 551.36 | 509.64 | 470.42 | 444.22 | 438.06 | 453.59 | 486.64 | 528.37 | 567.59 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | 56.28 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | -121.59 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 102.58 | 100.12 | 95.01 | 88.08 | 83.57 | 77.23 | 71.84 | 78.75 | 81.2 | 88.38 | 96.49 | 100.13 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 922.06 | 913.61 | 874.97 | 815.91 | 754.68 | 702.21 | 673.64 | 686.53 | 722.52 | 781.82 | 846.66 | 896.43 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | Access Factor Table 6d | Area m² | Flux Table 6a | g_ Table 6b | FF Table 6c | Gains (W) |
|---|---|---|---|---|---|---|

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 1 | x | 2.8 | x | 19.64 | x | 0.9 | x | 0.9 | = | 40.09 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 38.42 | x | 0.9 | x | 0.9 | = | 78.42 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 63.27 | x | 0.9 | x | 0.9 | = | 129.15 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 92.28 | x | 0.9 | x | 0.9 | = | 188.36 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 113.09 | x | 0.9 | x | 0.9 | = | 230.84 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 115.77 | x | 0.9 | x | 0.9 | = | 236.31 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 110.22 | x | 0.9 | x | 0.9 | = | 224.98 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 94.68 | x | 0.9 | x | 0.9 | = | 193.25 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 73.59 | x | 0.9 | x | 0.9 | = | 150.21 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 45.59 | x | 0.9 | x | 0.9 | = | 93.06 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 24.49 | x | 0.9 | x | 0.9 | = | 49.99 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 16.15 | x | 0.9 | x | 0.9 | = | 32.97 | (76) |
| South | 0.9x | 1 | x | 0.9 | x | 46.75 | x | 0.9 | x | 0.9 | = | 153.37 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 46.75 | x | 0.9 | x | 0.9 | = | 81.8 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 46.75 | x | 0.9 | x | 0.9 | = | 40.9 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 76.57 | x | 0.9 | x | 0.9 | = | 251.18 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 76.57 | x | 0.9 | x | 0.9 | = | 133.96 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 76.57 | x | 0.9 | x | 0.9 | = | 66.98 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 97.53 | x | 0.9 | x | 0.9 | = | 319.96 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 97.53 | x | 0.9 | x | 0.9 | = | 170.65 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 97.53 | x | 0.9 | x | 0.9 | = | 85.32 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 110.23 | x | 0.9 | x | 0.9 | = | 361.62 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 110.23 | x | 0.9 | x | 0.9 | = | 192.87 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 110.23 | x | 0.9 | x | 0.9 | = | 96.43 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 114.87 | x | 0.9 | x | 0.9 | = | 376.83 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 114.87 | x | 0.9 | x | 0.9 | = | 200.98 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 114.87 | x | 0.9 | x | 0.9 | = | 100.49 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 110.55 | x | 0.9 | x | 0.9 | = | 362.65 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 110.55 | x | 0.9 | x | 0.9 | = | 193.41 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 110.55 | x | 0.9 | x | 0.9 | = | 96.71 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 108.01 | x | 0.9 | x | 0.9 | = | 354.33 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 108.01 | x | 0.9 | x | 0.9 | = | 188.98 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 108.01 | x | 0.9 | x | 0.9 | = | 94.49 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 104.89 | x | 0.9 | x | 0.9 | = | 344.11 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 104.89 | x | 0.9 | x | 0.9 | = | 183.52 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 104.89 | x | 0.9 | x | 0.9 | = | 91.76 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 101.89 | x | 0.9 | x | 0.9 | = | 334.24 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 101.89 | x | 0.9 | x | 0.9 | = | 178.26 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 101.89 | x | 0.9 | x | 0.9 | = | 89.13 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 82.59 | x | 0.9 | x | 0.9 | = | 270.92 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 82.59 | x | 0.9 | x | 0.9 | = | 144.49 | (78) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 1.2 | x | 82.59 | x | 0.9 | x | 0.9 | = | 72.25 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 55.42 | x | 0.9 | x | 0.9 | = | 181.8 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 55.42 | x | 0.9 | x | 0.9 | = | 96.96 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 55.42 | x | 0.9 | x | 0.9 | = | 48.48 | (78) |
| South | 0.9x | 1 | x | 0.9 | x | 40.4 | x | 0.9 | x | 0.9 | = | 132.53 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 40.4 | x | 0.9 | x | 0.9 | = | 70.68 | (78) |
| South | 0.9x | 1 | x | 1.2 | x | 40.4 | x | 0.9 | x | 0.9 | = | 35.34 | (78) |

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 316.16 | 530.55 | 705.08 | 839.29 | 909.15 | 889.08 | 862.78 | 812.64 | 751.83 | 580.72 | 377.22 | 271.51 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1238.21 | 1444.16 | 1580.05 | 1655.2 | 1663.83 | 1591.29 | 1536.41 | 1499.17 | 1474.36 | 1362.54 | 1223.88 | 1167.94 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 1 | 0.99 | 0.96 | 0.89 | 0.72 | 0.53 | 0.57 | 0.81 | 0.97 | 1 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 20.13 | 20.27 | 20.46 | 20.69 | 20.88 | 20.98 | 21 | 21 | 20.95 | 20.72 | 20.38 | 20.11 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 20.21 | 20.22 | 20.22 | 20.23 | 20.23 | 20.24 | 20.24 | 20.24 | 20.23 | 20.23 | 20.22 | 20.22 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 1 | 1 | 0.99 | 0.95 | 0.86 | 0.65 | 0.44 | 0.48 | 0.74 | 0.96 | 1 | 1 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 19.04 | 19.25 | 19.53 | 19.86 | 20.1 | 20.22 | 20.24 | 20.24 | 20.2 | 19.9 | 19.41 | 19.01 | (90) |

fLA = Living area ÷ (4) = 0.23 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.29 | 19.49 | 19.75 | 20.05 | 20.29 | 20.4 | 20.41 | 20.42 | 20.37 | 20.09 | 19.63 | 19.27 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.29 | 19.49 | 19.75 | 20.05 | 20.29 | 20.4 | 20.41 | 20.42 | 20.37 | 20.09 | 19.63 | 19.27 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 1 | 0.99 | 0.98 | 0.95 | 0.86 | 0.67 | 0.46 | 0.5 | 0.76 | 0.96 | 0.99 | 1 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1235.36 | 1434.91 | 1552.7 | 1571.26 | 1429.08 | 1058.6 | 713.03 | 747.56 | 1115.46 | 1302.45 | 1216.43 | 1166.06 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 2906.87 | 2819.87 | 2553.41 | 2121.85 | 1629.25 | 1087.52 | 715.4 | 751.33 | 1181.93 | 1800.56 | 2390.38 | 2888.42 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1243.61 | 930.7 | 744.53 | 396.42 | 148.93 | 0 | 0 | 0 | 0 | 370.59 | 845.24 | 1281.44 | |

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Total per year (kWh/year) = Sum(98)1...5,9...12 = | 5961.46 | (98)

Space heating requirement in kWh/m²/year | 26.03 | (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1762.83 | 1387.76 | 1422.15 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.82 | 0.91 | 0.89 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1447.03 | 1261.66 | 1267.57 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 1591.29 | 1536.41 | 1499.17 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 103.86 | 204.42 | 172.31 | 0 | 0 | 0 | 0 | |

Total = Sum(104)6...8 = | 480.59 | (104)

Cooled fraction — f C = cooled area ÷ (4) = | 1 | (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)6...8* = | 0 | (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 25.97 | 51.1 | 43.08 | 0 | 0 | 0 | 0 |

Total = Sum(107)6...8 = | 120.15 | (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = | 0.52 | (108)

## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | 0 | (301)

Fraction of space heat from community system 1 – (301) = | 1 | (302)

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

Fraction of heat from Community heat pump | 1 | (303a)

Fraction of total space heat from Community heat pump (302) x (303a) = | 1 | (304a)

Factor for control and charging method (Table 4c(3)) for community heating system | 1 | (305)

Distribution loss factor (Table 12c) for community heating system | 1.05 | (306)

| **Space heating** | | **kWh/year** | |
|---|---|---|---|
| Annual space heating requirement | | 5961.46 | |
| Space heat from Community heat pump | (98) x (304a) x (305) x (306) = | 6259.54 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |

**Water heating**

Annual water heating requirement | 1983.52

If DHW from community scheme:

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| | | | |
|---|---|---|---|
| Water heat from Community heat pump | (64) x (303a) x (305) x (306) = | 2082.69 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 83.42 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 35.6 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 767.34 | (332) |

## 10b. Fuel costs – Community heating scheme

| | Fuel kWh/year | | Fuel Price (Table 12) | | Fuel Cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from CHP | (307a) | x | 4.24 | x 0.01 = | 265.4 | (340a) |
| Water heating from CHP | (310a) | x | 4.24 | x 0.01 = | 88.31 | (342a) |
| | | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | | 13.19 | x 0.01 = | 4.7 | (348) |
| Pumps and fans | (331) | | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | | 13.19 | x 0.01 = | 101.21 | (350) |
| Additional standing charges (Table 12) | | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | | 579.62 | (355) |



## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 0.89 | (357) |
| **SAP rating (section12)** | | 87.61 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | Energy kWh/year | Emission factor kg CO2/kWh | | Emissions kg CO2/year | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1237.03 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 43.3 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1280.33 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1280.33 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 18.48 | (377) |

| | | | | | |
|---|---|---|---|---|---|
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | 0.52 | = | 398.25 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | 1697.06 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | 7.41 | (384) |
| **EI rating (section 14)** | | | | 91.7 | (385) |

## 13b. Primary Energy – Community heating scheme

| | | Energy kWh/year | Primary factor | | P.Energy kWh/year | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 7317.33 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 256.11 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 7573.43 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 7573.43 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | | 7573.43 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = | 109.29 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = | 2355.75 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | | 10038.47 | (383) |

# SAP WorkSheet: New dwelling design stage

User Details:

**Assessor Name:** | **Stroma Number:**
**Software Name:** Stroma FSAP 2012 | **Software Version:** Version: 1.0.3.11

Property Address: Flat 3

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | | Av. Height(m) | | | Volume(m³) | |
|---|---|---|---|---|---|---|---|---|
| Ground floor | 65 | (1a) | x | 3.1 | (2a) | = | 201.5 | (3a) |
| First floor | 178 | (1b) | x | 2.9 | (2b) | = | 516.2 | (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 243 | (4) | | | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) | | = | 717.7 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 4 | x 10 = | 40 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

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| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 40 | ÷ (5) = | 0.06 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |
| *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | | |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.28 | (18) |
| *Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used* | | | |
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.26 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

# SAP WorkSheet: New dwelling design stage



Wind Factor (22a)m = (22)m ÷ 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.33 | 0.32 | 0.32 | 0.29 | 0.28 | 0.25 | 0.25 | 0.24 | 0.26 | 0.28 | 0.29 | 0.31 |

*Calculate effective air change rate for the applicable case*

| | | |
|---|---|---|
| If mechanical ventilation: | 0 | (23a) |
| If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) | 0 | (23b) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = | 0 | (23c) |

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

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

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.55 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 1.5 | x1/[1/( 1.2 )+ 0.04] | | = | 1.72 | | | (27) |
| Windows Type 2 | | | 2.44 | x1/[1/( 1.2 )+ 0.04] | | = | 2.79 | | | (27) |
| Windows Type 3 | | | 0.9 | x1/[1/( 1.2 )+ 0.04] | | = | 1.03 | | | (27) |
| Windows Type 4 | | | 1.4 | x1/[1/( 1.2 )+ 0.04] | | = | 1.6 | | | (27) |
| Windows Type 5 | | | 0.91 | x1/[1/( 1.2 )+ 0.04] | | = | 1.04 | | | (27) |
| Windows Type 6 | | | 1.58 | x1/[1/( 1.2 )+ 0.04] | | = | 1.81 | | | (27) |
| Windows Type 7 | | | 1.6 | x1/[1/( 1.2 )+ 0.04] | | = | 1.83 | | | (27) |
| Rooflights | | | 0.5 | x1/[1/(1.3) + 0.04] | | = | 0.65 | | | (27b) |
| Walls Type1 | 20.16 | 9.5 | 10.66 | x | 0.12 | = | 1.28 | | | (29) |
| Walls Type2 | 11.89 | 0 | 11.89 | x | 0.12 | = | 1.43 | | | (29) |
| Walls Type3 | 6.51 | 6.37 | 0.14 | x | 0.11 | = | 0.02 | | | (29) |
| Walls Type4 | 14.26 | 0 | 14.26 | x | 0.12 | = | 1.71 | | | (29) |
| Walls Type5 | 35.67 | 28.5 | 7.17 | x | 0.12 | = | 0.86 | | | (29) |
| Walls Type6 | 78.3 | 0 | 78.3 | x | 0.12 | = | 9.4 | | | (29) |
| Roof | 25 | 1 | 24 | x | 0.13 | = | 3.12 | | | (30) |
| Total area of elements, m² | | | 193.89 | | | | | | | (31) |

# SAP WorkSheet: New dwelling design stage

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 71.53 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 216 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 29.08 | (36) |

*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 100.61 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 131.4 | 130.9 | 130.4 | 128.08 | 127.65 | 125.63 | 125.63 | 125.25 | 126.41 | 127.65 | 128.53 | 129.45 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 232.02 | 231.51 | 231.02 | 228.7 | 228.26 | 226.24 | 226.24 | 225.87 | 227.02 | 228.26 | 229.14 | 230.06 | |

Average = Sum(39)1…12 /12= 228.69 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 0.95 | 0.95 | 0.95 | 0.94 | 0.94 | 0.93 | 0.93 | 0.93 | 0.93 | 0.94 | 0.94 | 0.95 | |

Average = Sum(40)1…12 /12= 0.94 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |



## 4. Water heating energy requirement: kWh/year:

| | | |
|---|---|---|
| Assumed occupancy, N | 3.06 | (42) |

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

| | | |
|---|---|---|
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 106.82 | (43) |

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 117.51 | 113.23 | 108.96 | 104.69 | 100.41 | 96.14 | 96.14 | 100.41 | 104.69 | 108.96 | 113.23 | 117.51 | |

Total = Sum(44)1…12 = 1281.88 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 174.26 | 152.41 | 157.27 | 137.11 | 131.56 | 113.53 | 105.2 | 120.72 | 122.16 | 142.37 | 155.4 | 168.76 | |

Total = Sum(45)1…12 = 1680.75 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 26.14 | 22.86 | 23.59 | 20.57 | 19.73 | 17.03 | 15.78 | 18.11 | 18.32 | 21.36 | 23.31 | 25.31 | (46) |

Water storage loss:

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 1 | (47) |

If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)
Water storage loss:

| | | |
|---|---|---|
| a) If manufacturer's declared loss factor is known (kWh/day): | 0 | (48) |
| Temperature factor from Table 2b | 0 | (49) |

# SAP WorkSheet: New dwelling design stage

| | | | |
|---|---|---|---|
| Energy lost from water storage, kWh/year | (48) x (49) = | 1 | (50) |
| b) If manufacturer's declared cylinder loss factor is not known: | | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | | 0.03 | (51) |
| If community heating see section 4.3 | | | |
| Volume factor from Table 2a | | 4.93 | (52) |
| Temperature factor from Table 2b | | 0.6 | (53) |
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0.1 | (54) |
| Enter (50) or (54) in (55) | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m
(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 200.55 | 176.15 | 183.56 | 162.56 | 157.85 | 138.97 | 131.49 | 147.01 | 147.61 | 168.66 | 180.85 | 195.05 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 200.55 | 176.15 | 183.56 | 162.56 | 157.85 | 138.97 | 131.49 | 147.01 | 147.61 | 168.66 | 180.85 | 195.05 |

Output from water heater (annual)1…12 — 1990.32 (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 76.55 | 67.48 | 70.9 | 63.6 | 62.35 | 55.76 | 53.59 | 58.75 | 58.63 | 65.95 | 69.68 | 74.72 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | 183.47 | (66) |
| Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5 | | | | | | | | | | | | | |
| (67)m= | 91.44 | 81.22 | 66.05 | 50 | 37.38 | 31.56 | 34.1 | 44.32 | 59.49 | 75.53 | 88.16 | 93.98 | (67) |
| Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5 | | | | | | | | | | | | | |
| (68)m= | 612.35 | 618.7 | 602.69 | 568.6 | 525.57 | 485.13 | 458.11 | 451.76 | 467.77 | 501.86 | 544.89 | 585.33 | (68) |
| Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5 | | | | | | | | | | | | | |
| (69)m= | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | 56.4 | (69) |
| Pumps and fans gains (Table 5a) | | | | | | | | | | | | | |
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |
| Losses e.g. evaporation (negative values) (Table 5) | | | | | | | | | | | | | |
| (71)m= | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | -122.31 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 102.89 | 100.42 | 95.3 | 88.33 | 83.81 | 77.44 | 72.03 | 78.96 | 81.43 | 88.64 | 96.78 | 100.43 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 924.24 | 917.9 | 881.6 | 824.5 | 764.32 | 711.69 | 681.8 | 692.6 | 726.25 | 783.59 | 847.39 | 897.31 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 1.58 | x | 10.63 | x | 0.9 | x | 0.9 | = | 61.24 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 10.63 | x | 0.9 | x | 0.9 | = | 12.4 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 20.32 | x | 0.9 | x | 0.9 | = | 117.03 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 20.32 | x | 0.9 | x | 0.9 | = | 23.7 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 34.53 | x | 0.9 | x | 0.9 | = | 198.86 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 34.53 | x | 0.9 | x | 0.9 | = | 40.28 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 55.46 | x | 0.9 | x | 0.9 | = | 319.43 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 55.46 | x | 0.9 | x | 0.9 | = | 64.69 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 74.72 | x | 0.9 | x | 0.9 | = | 430.3 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 74.72 | x | 0.9 | x | 0.9 | = | 87.15 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 79.99 | x | 0.9 | x | 0.9 | = | 460.64 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 79.99 | x | 0.9 | x | 0.9 | = | 93.29 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 74.68 | x | 0.9 | x | 0.9 | = | 430.07 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 74.68 | x | 0.9 | x | 0.9 | = | 87.1 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 59.25 | x | 0.9 | x | 0.9 | = | 341.21 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 59.25 | x | 0.9 | x | 0.9 | = | 69.1 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 41.52 | x | 0.9 | x | 0.9 | = | 239.1 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 41.52 | x | 0.9 | x | 0.9 | = | 48.42 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 24.19 | x | 0.9 | x | 0.9 | = | 139.31 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 24.19 | x | 0.9 | x | 0.9 | = | 28.21 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 13.12 | x | 0.9 | x | 0.9 | = | 75.55 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 13.12 | x | 0.9 | x | 0.9 | = | 15.3 | (74) |
| North | 0.9x | 1 | x | 1.58 | x | 8.86 | x | 0.9 | x | 0.9 | = | 51.05 | (74) |
| North | 0.9x | 1 | x | 1.6 | x | 8.86 | x | 0.9 | x | 0.9 | = | 10.34 | (74) |
| South | 0.9x | 1 | x | 0.91 | x | 46.75 | x | 0.9 | x | 0.9 | = | 217.1 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 76.57 | x | 0.9 | x | 0.9 | = | 355.56 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 97.53 | x | 0.9 | x | 0.9 | = | 452.92 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.23 | x | 0.9 | x | 0.9 | = | 511.9 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 114.87 | x | 0.9 | x | 0.9 | = | 533.43 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.55 | x | 0.9 | x | 0.9 | = | 513.35 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 108.01 | x | 0.9 | x | 0.9 | = | 501.58 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 104.89 | x | 0.9 | x | 0.9 | = | 487.1 | (78) |

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 0.91 | x | 101.89 | x | 0.9 | x | 0.9 | = | 473.13 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 82.59 | x | 0.9 | x | 0.9 | = | 383.51 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 55.42 | x | 0.9 | x | 0.9 | = | 257.34 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 40.4 | x | 0.9 | x | 0.9 | = | 187.6 | (78) |
| West | 0.9x | 1 | x | 1.5 | x | 19.64 | x | 0.9 | x | 0.9 | = | 107.38 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 19.64 | x | 0.9 | x | 0.9 | = | 174.68 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 19.64 | x | 0.9 | x | 0.9 | = | 25.77 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 19.64 | x | 0.9 | x | 0.9 | = | 100.22 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 38.42 | x | 0.9 | x | 0.9 | = | 210.06 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 38.42 | x | 0.9 | x | 0.9 | = | 341.7 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 38.42 | x | 0.9 | x | 0.9 | = | 50.42 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 38.42 | x | 0.9 | x | 0.9 | = | 196.06 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 63.27 | x | 0.9 | x | 0.9 | = | 345.95 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 63.27 | x | 0.9 | x | 0.9 | = | 562.74 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 63.27 | x | 0.9 | x | 0.9 | = | 83.03 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 63.27 | x | 0.9 | x | 0.9 | = | 322.88 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 92.28 | x | 0.9 | x | 0.9 | = | 504.54 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 92.28 | x | 0.9 | x | 0.9 | = | 820.72 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 92.28 | x | 0.9 | x | 0.9 | = | 121.09 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 92.28 | x | 0.9 | x | 0.9 | = | 470.91 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 113.09 | x | 0.9 | x | 0.9 | = | 618.33 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 113.09 | x | 0.9 | x | 0.9 | = | 1005.82 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 113.09 | x | 0.9 | x | 0.9 | = | 148.4 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 113.09 | x | 0.9 | x | 0.9 | = | 577.11 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 115.77 | x | 0.9 | x | 0.9 | = | 632.98 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 115.77 | x | 0.9 | x | 0.9 | = | 1029.64 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 115.77 | x | 0.9 | x | 0.9 | = | 151.91 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 115.77 | x | 0.9 | x | 0.9 | = | 590.78 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 110.22 | x | 0.9 | x | 0.9 | = | 602.62 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 110.22 | x | 0.9 | x | 0.9 | = | 980.26 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 110.22 | x | 0.9 | x | 0.9 | = | 144.63 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 110.22 | x | 0.9 | x | 0.9 | = | 562.44 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 94.68 | x | 0.9 | x | 0.9 | = | 517.64 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 94.68 | x | 0.9 | x | 0.9 | = | 842.03 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 94.68 | x | 0.9 | x | 0.9 | = | 124.23 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 94.68 | x | 0.9 | x | 0.9 | = | 483.13 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 73.59 | x | 0.9 | x | 0.9 | = | 402.35 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 73.59 | x | 0.9 | x | 0.9 | = | 654.49 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 73.59 | x | 0.9 | x | 0.9 | = | 96.56 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 73.59 | x | 0.9 | x | 0.9 | = | 375.53 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 45.59 | x | 0.9 | x | 0.9 | = | 249.26 | (80) |

| | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.9x | 1 | x | 2.44 | x | 45.59 | x | 0.9 | x | 0.9 | = | 405.46 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 45.59 | x | 0.9 | x | 0.9 | = | 59.82 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 45.59 | x | 0.9 | x | 0.9 | = | 232.64 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 24.49 | x | 0.9 | x | 0.9 | = | 133.89 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 24.49 | x | 0.9 | x | 0.9 | = | 217.8 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 24.49 | x | 0.9 | x | 0.9 | = | 32.13 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 24.49 | x | 0.9 | x | 0.9 | = | 124.97 | (80) |
| West | 0.9x | 1 | x | 1.5 | x | 16.15 | x | 0.9 | x | 0.9 | = | 88.31 | (80) |
| West | 0.9x | 1 | x | 2.44 | x | 16.15 | x | 0.9 | x | 0.9 | = | 143.65 | (80) |
| West | 0.9x | 1 | x | 0.9 | x | 16.15 | x | 0.9 | x | 0.9 | = | 21.19 | (80) |
| West | 0.9x | 1 | x | 1.4 | x | 16.15 | x | 0.9 | x | 0.9 | = | 82.42 | (80) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 26 | x | 0.7 | x | 0.7 | = | 11.47 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 54 | x | 0.7 | x | 0.7 | = | 23.81 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 96 | x | 0.7 | x | 0.7 | = | 42.34 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 150 | x | 0.7 | x | 0.7 | = | 66.15 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 192 | x | 0.7 | x | 0.7 | = | 84.67 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 200 | x | 0.7 | x | 0.7 | = | 88.2 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 189 | x | 0.7 | x | 0.7 | = | 83.35 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 157 | x | 0.7 | x | 0.7 | = | 69.24 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 115 | x | 0.7 | x | 0.7 | = | 50.71 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 66 | x | 0.7 | x | 0.7 | = | 29.11 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 33 | x | 0.7 | x | 0.7 | = | 14.55 | (82) |
| Rooflights | 0.9x | 1 | x | 0.5 | x | 21 | x | 0.7 | x | 0.7 | = | 9.26 | (82) |



Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 710.27 | 1318.35 | 2048.99 | 2879.43 | 3485.22 | 3560.8 | 3392.05 | 2933.68 | 2340.29 | 1527.32 | 871.54 | 593.82 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1634.51 | 2236.26 | 2930.59 | 3703.93 | 4249.54 | 4272.49 | 4073.85 | 3626.28 | 3066.54 | 2310.91 | 1718.93 | 1491.12 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 0.98 | 0.9 | 0.71 | 0.5 | 0.34 | 0.24 | 0.29 | 0.51 | 0.87 | 0.99 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 20.1 | 20.38 | 20.72 | 20.94 | 20.99 | 21 | 21 | 21 | 20.99 | 20.85 | 20.4 | 20.05 | (87) |

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

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

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 1 | 0.97 | 0.88 | 0.67 | 0.45 | 0.29 | 0.2 | 0.23 | 0.44 | 0.83 | 0.98 | 1 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.92 | 19.33 | 19.8 | 20.07 | 20.13 | 20.14 | 20.14 | 20.14 | 20.13 | 19.98 | 19.37 | 18.85 | (90) |

fLA = Living area ÷ (4) = | 0.18 | (91)

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Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.13 | 19.52 | 19.96 | 20.23 | 20.28 | 20.29 | 20.29 | 20.29 | 20.29 | 20.13 | 19.55 | 19.06 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.13 | 19.52 | 19.96 | 20.23 | 20.28 | 20.29 | 20.29 | 20.29 | 20.29 | 20.13 | 19.55 | 19.06 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.99 | 0.97 | 0.88 | 0.67 | 0.46 | 0.3 | 0.21 | 0.24 | 0.46 | 0.83 | 0.98 | 1 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1623.41 | 2165.17 | 2574.47 | 2488.27 | 1948.07 | 1287.24 | 835.49 | 879.42 | 1397.23 | 1915.27 | 1683.66 | 1484.76 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 3440.76 | 3384.2 | 3109.38 | 2590.77 | 1958.82 | 1287.94 | 835.54 | 879.56 | 1404.54 | 2176.38 | 2853.24 | 3418.64 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1352.11 | 819.19 | 397.98 | 73.8 | 8 | 0 | 0 | 0 | 0 | 194.26 | 842.1 | 1438.81 | |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 5126.24 (98)

Space heating requirement in kWh/m²/year 21.1 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 2126.66 | 1674.18 | 1716.58 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.99 | 1 | 0.99 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 2109.98 | 1669.3 | 1706.21 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 4272.49 | 4073.85 | 3626.28 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 1557.01 | 1788.98 | 1428.54 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 4774.52 (104)

Cooled fraction — f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 389.25 | 447.24 | 357.13 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 1193.63 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 4.91 (108)

## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

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| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community heat pump | | 1 | (303a) |
| Fraction of total space heat from Community heat pump | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 5126.24 | |
| Space heat from Community heat pump | (98) x (304a) x (305) x (306) = | 5382.56 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1990.32 | |
| If DHW from community scheme:<br>Water heat from Community heat pump | (64) x (303a) x (305) x (306) = | 2089.84 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 74.72 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 353.67 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f):<br>mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 645.95 | (332) |

## 10b. Fuel costs – Community heating scheme

| | **Fuel**<br>kWh/year | | **Fuel Price**<br>(Table 12) | | **Fuel Cost**<br>£/year | |
|---|---|---|---|---|---|---|
| Space heating from CHP | (307a) | x | 4.24 | x 0.01 = | 228.22 | (340a) |
| Water heating from CHP | (310a) | x | 4.24 | x 0.01 = | 88.61 | (342a) |
| | | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | | 13.19 | x 0.01 = | 46.65 | (348) |
| Pumps and fans | (331) | | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | | 13.19 | x 0.01 = | 85.2 | (350) |
| Additional standing charges (Table 12) | | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | | 568.68 | (355) |

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## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 0.83 | (357) |
| **SAP rating (section12)** | | 88.43 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | Energy kWh/year | Emission factor kg CO2/kWh | | Emissions kg CO2/year | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1108.05 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 38.78 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1146.83 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1146.83 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 183.55 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 335.25 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | | 1665.63 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | | 6.85 | (384) |
| **EI rating (section 14)** | | | | | 92.25 | (385) |

## 13b. Primary Energy – Community heating scheme

| | | Energy kWh/year | Primary factor | | P.Energy kWh/year | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 6554.35 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 229.4 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 6783.76 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 6783.76 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | | 6783.76 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = | 1085.76 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = | 1983.06 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | | 9852.58 | (383) |

# SAP WorkSheet: New dwelling design stage

**User Details:**

| | | | |
|---|---|---|---|
| **Assessor Name:** | | **Stroma Number:** | |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.3.11 |

**Property Address: Flat 4**

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | | Av. Height(m) | | | Volume(m³) | |
|---|---|---|---|---|---|---|---|---|
| Ground floor | 178 | (1a) | x | 2.9 | (2a) | = | 516.2 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 178 | (4) | | | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | | | 516.2 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 5 | x 10 = | 50 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |

DRAFT

| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 50 | ÷ (5) = | 0.1 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |

*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*

| | | | |
|---|---|---|---|
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.32 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.3 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |
| Wind Factor (22a)m = (22)m ÷ 4 | | | | | | | | | | | | |
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

# SAP WorkSheet: New dwelling design stage

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.38 | 0.37 | 0.36 | 0.33 | 0.32 | 0.28 | 0.28 | 0.28 | 0.3 | 0.32 | 0.33 | 0.35 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.57 | 0.57 | 0.57 | 0.55 | 0.55 | 0.54 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 0.91 | x1/[1/( 1.2 )+ 0.04] | | = | 1.04 | | | (27) |
| Windows Type 2 | | | 0.97 | x1/[1/( 1.2 )+ 0.04] | | = | 1.11 | | | (27) |
| Windows Type 3 | | | 0.79 | x1/[1/( 1.2 )+ 0.04] | | = | 0.9 | | | (27) |
| Windows Type 4 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 5 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 6 | | | 0.78 | x1/[1/( 1.2 )+ 0.04] | | = | 0.89 | | | (27) |
| Windows Type 7 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 8 | | | 2.5 | x1/[1/( 1.2 )+ 0.04] | | = | 2.86 | | | (27) |
| Walls Type1 | 28.13 | 0 | 28.13 | x | 0.12 | = | 3.38 | | | (29) |
| Walls Type2 | 21.46 | 0 | 21.46 | x | 0.11 | = | 2.32 | | | (29) |
| Walls Type3 | 28.13 | 0 | 28.13 | x | 0.12 | = | 3.38 | | | (29) |
| Walls Type4 | 59.45 | 12.7 | 46.75 | x | 0.12 | = | 5.61 | | | (29) |
| Total area of elements, m² | | | 156.17 | | | | | | | (31) |

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 50.26 (33)

Heat capacity Cm = S(A x k ) ((28)…(30) + (32) + (32a)…(32e) = 0 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f*

# SAP WorkSheet: New dwelling design stage

*can be used instead of a detailed calculation.*

Thermal bridges : S (L x Y) calculated using Appendix K | 23.43 | (36)

*if details of thermal bridging are not known (36) = 0.15 x (31)*

Total fabric heat loss (33) + (36) = | 73.68 | (37)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 97.45 | 96.97 | 96.5 | 94.31 | 93.9 | 91.99 | 91.99 | 91.63 | 92.72 | 93.9 | 94.73 | 95.6 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 171.13 | 170.65 | 170.19 | 167.99 | 167.58 | 165.67 | 165.67 | 165.32 | 166.41 | 167.58 | 168.41 | 169.28 | |

Average = Sum(39)$_{1\ldots12}$ /12= | 167.99 | (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 0.96 | 0.96 | 0.96 | 0.94 | 0.94 | 0.93 | 0.93 | 0.93 | 0.93 | 0.94 | 0.95 | 0.95 |

Average = Sum(40)$_{1\ldots12}$ /12= | 0.94 | (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |

## 4. Water heating energy requirement: kWh/year:



Assumed occupancy, N | 2.97 | (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 104.81 | (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 115.29 | 111.1 | 106.91 | 102.72 | 98.52 | 94.33 | 94.33 | 98.52 | 102.72 | 106.91 | 111.1 | 115.29 |

Total = Sum(44)$_{1\ldots12}$ = | 1257.76 | (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 170.98 | 149.54 | 154.31 | 134.53 | 129.09 | 111.39 | 103.22 | 118.45 | 119.86 | 139.69 | 152.48 | 165.58 |

Total = Sum(45)$_{1\ldots12}$ = | 1649.12 | (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.65 | 22.43 | 23.15 | 20.18 | 19.36 | 16.71 | 15.48 | 17.77 | 17.98 | 20.95 | 22.87 | 24.84 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel | 1 | (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): | 0 | (48)

Temperature factor from Table 2b | 0 | (49)

Energy lost from water storage, kWh/year (48) x (49) = | 1 | (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) | 0.03 | (51)

If community heating see section 4.3

Volume factor from Table 2a | 4.93 | (52)

Temperature factor from Table 2b | 0.6 | (53)

| | | | |
|---|---|---|---|
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0.1 | (54) |
| Enter (50) or (54) in (55) | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

| | | |
|---|---|---|
| Primary circuit loss (annual) from Table 3 | 0 | (58) |

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 197.27 | 173.29 | 180.6 | 159.98 | 155.38 | 136.84 | 129.51 | 144.74 | 145.31 | 165.98 | 177.92 | 191.88 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 197.27 | 173.29 | 180.6 | 159.98 | 155.38 | 136.84 | 129.51 | 144.74 | 145.31 | 165.98 | 177.92 | 191.88 | |

| | | |
|---|---|---|
| Output from water heater (annual)$_{1…12}$ | 1958.69 | (64) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 75.46 | 66.53 | 69.92 | 62.74 | 61.53 | 55.05 | 52.93 | 57.99 | 57.86 | 65.06 | 68.71 | 73.67 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | 178.39 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 77.92 | 69.21 | 56.29 | 42.61 | 31.85 | 26.89 | 29.06 | 37.77 | 50.69 | 64.37 | 75.13 | 80.09 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 521.83 | 527.24 | 513.6 | 484.55 | 447.88 | 413.41 | 390.39 | 384.97 | 398.62 | 427.67 | 464.34 | 498.8 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | 55.81 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | -118.93 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 101.43 | 99 | 93.98 | 87.14 | 82.7 | 76.45 | 71.14 | 77.95 | 80.37 | 87.44 | 95.43 | 99.01 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 816.45 | 810.73 | 779.13 | 729.57 | 677.71 | 632.03 | 605.86 | 615.97 | 644.95 | 694.75 | 750.17 | 793.18 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 0.97 | x | 10.63 | x | 0.9 | x | 0.9 | = | 37.6 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 10.63 | x | 0.9 | x | 0.9 | = | 18.37 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 10.63 | x | 0.9 | x | 0.9 | = | 21.7 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 20.32 | x | 0.9 | x | 0.9 | = | 71.85 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 20.32 | x | 0.9 | x | 0.9 | = | 35.11 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 20.32 | x | 0.9 | x | 0.9 | = | 41.48 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 34.53 | x | 0.9 | x | 0.9 | = | 122.09 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 34.53 | x | 0.9 | x | 0.9 | = | 59.66 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 34.53 | x | 0.9 | x | 0.9 | = | 70.48 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 55.46 | x | 0.9 | x | 0.9 | = | 196.1 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 55.46 | x | 0.9 | x | 0.9 | = | 95.83 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 55.46 | x | 0.9 | x | 0.9 | = | 113.21 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 74.72 | x | 0.9 | x | 0.9 | = | 264.17 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 74.72 | x | 0.9 | x | 0.9 | = | 129.09 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 74.72 | x | 0.9 | x | 0.9 | = | 152.51 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 79.99 | x | 0.9 | x | 0.9 | = | 282.8 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 79.99 | x | 0.9 | x | 0.9 | = | 138.19 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 79.99 | x | 0.9 | x | 0.9 | = | 163.27 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 74.68 | x | 0.9 | x | 0.9 | = | 264.03 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 74.68 | x | 0.9 | x | 0.9 | = | 129.02 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 74.68 | x | 0.9 | x | 0.9 | = | 152.43 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 59.25 | x | 0.9 | x | 0.9 | = | 209.47 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 59.25 | x | 0.9 | x | 0.9 | = | 102.36 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 59.25 | x | 0.9 | x | 0.9 | = | 120.93 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 41.52 | x | 0.9 | x | 0.9 | = | 146.79 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 41.52 | x | 0.9 | x | 0.9 | = | 71.73 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 41.52 | x | 0.9 | x | 0.9 | = | 84.74 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 24.19 | x | 0.9 | x | 0.9 | = | 85.53 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 24.19 | x | 0.9 | x | 0.9 | = | 41.79 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 24.19 | x | 0.9 | x | 0.9 | = | 49.38 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 13.12 | x | 0.9 | x | 0.9 | = | 46.38 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 13.12 | x | 0.9 | x | 0.9 | = | 22.66 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 13.12 | x | 0.9 | x | 0.9 | = | 26.78 | (74) |
| North | 0.9x | 1 | x | 0.97 | x | 8.86 | x | 0.9 | x | 0.9 | = | 31.34 | (74) |
| North | 0.9x | 1 | x | 0.79 | x | 8.86 | x | 0.9 | x | 0.9 | = | 15.32 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 8.86 | x | 0.9 | x | 0.9 | = | 18.09 | (74) |
| East | 0.9x | 2 | x | 2.8 | x | 19.64 | x | 0.9 | x | 0.9 | = | 80.18 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 19.64 | x | 0.9 | x | 0.9 | = | 71.59 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 38.42 | x | 0.9 | x | 0.9 | = | 156.85 | (76) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 2 | x | 2.5 | x | 38.42 | x | 0.9 | x | 0.9 | = | 140.04 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 63.27 | x | 0.9 | x | 0.9 | = | 258.31 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 63.27 | x | 0.9 | x | 0.9 | = | 230.63 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 92.28 | x | 0.9 | x | 0.9 | = | 376.72 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 92.28 | x | 0.9 | x | 0.9 | = | 336.36 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 113.09 | x | 0.9 | x | 0.9 | = | 461.69 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 113.09 | x | 0.9 | x | 0.9 | = | 412.22 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 115.77 | x | 0.9 | x | 0.9 | = | 472.62 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 115.77 | x | 0.9 | x | 0.9 | = | 421.98 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 110.22 | x | 0.9 | x | 0.9 | = | 449.95 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 110.22 | x | 0.9 | x | 0.9 | = | 401.75 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 94.68 | x | 0.9 | x | 0.9 | = | 386.5 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 94.68 | x | 0.9 | x | 0.9 | = | 345.09 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 73.59 | x | 0.9 | x | 0.9 | = | 300.42 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 73.59 | x | 0.9 | x | 0.9 | = | 268.23 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 45.59 | x | 0.9 | x | 0.9 | = | 186.11 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 45.59 | x | 0.9 | x | 0.9 | = | 166.17 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 24.49 | x | 0.9 | x | 0.9 | = | 99.97 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 24.49 | x | 0.9 | x | 0.9 | = | 89.26 | (76) |
| East | 0.9x | 2 | x | 2.8 | x | 16.15 | x | 0.9 | x | 0.9 | = | 65.94 | (76) |
| East | 0.9x | 2 | x | 2.5 | x | 16.15 | x | 0.9 | x | 0.9 | = | 58.87 | (76) |
| South | 0.9x | 1 | x | 0.91 | x | 46.75 | x | 0.9 | x | 0.9 | = | 62.03 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 46.75 | x | 0.9 | x | 0.9 | = | 53.17 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 46.75 | x | 0.9 | x | 0.9 | = | 190.86 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 76.57 | x | 0.9 | x | 0.9 | = | 101.59 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 76.57 | x | 0.9 | x | 0.9 | = | 87.08 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 76.57 | x | 0.9 | x | 0.9 | = | 312.58 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 97.53 | x | 0.9 | x | 0.9 | = | 129.41 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 97.53 | x | 0.9 | x | 0.9 | = | 110.92 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 97.53 | x | 0.9 | x | 0.9 | = | 398.17 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.23 | x | 0.9 | x | 0.9 | = | 146.26 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 110.23 | x | 0.9 | x | 0.9 | = | 125.36 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 110.23 | x | 0.9 | x | 0.9 | = | 450.02 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 114.87 | x | 0.9 | x | 0.9 | = | 152.41 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 114.87 | x | 0.9 | x | 0.9 | = | 130.64 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 114.87 | x | 0.9 | x | 0.9 | = | 468.95 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.55 | x | 0.9 | x | 0.9 | = | 146.67 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 110.55 | x | 0.9 | x | 0.9 | = | 125.72 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 110.55 | x | 0.9 | x | 0.9 | = | 451.3 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 108.01 | x | 0.9 | x | 0.9 | = | 143.31 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 108.01 | x | 0.9 | x | 0.9 | = | 122.84 | (78) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 2.8 | x | 108.01 | x | 0.9 | x | 0.9 | = | 440.95 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 104.89 | x | 0.9 | x | 0.9 | = | 139.17 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 104.89 | x | 0.9 | x | 0.9 | = | 119.29 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 104.89 | x | 0.9 | x | 0.9 | = | 428.22 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 101.89 | x | 0.9 | x | 0.9 | = | 135.18 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 101.89 | x | 0.9 | x | 0.9 | = | 115.87 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 101.89 | x | 0.9 | x | 0.9 | = | 415.94 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 82.59 | x | 0.9 | x | 0.9 | = | 109.57 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 82.59 | x | 0.9 | x | 0.9 | = | 93.92 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 82.59 | x | 0.9 | x | 0.9 | = | 337.15 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 55.42 | x | 0.9 | x | 0.9 | = | 73.53 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 55.42 | x | 0.9 | x | 0.9 | = | 63.02 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 55.42 | x | 0.9 | x | 0.9 | = | 226.23 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 40.4 | x | 0.9 | x | 0.9 | = | 53.6 | (78) |
| South | 0.9x | 1 | x | 0.78 | x | 40.4 | x | 0.9 | x | 0.9 | = | 45.94 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 40.4 | x | 0.9 | x | 0.9 | = | 164.92 | (78) |

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 535.5 | 946.57 | 1379.66 | 1839.87 | 2171.67 | 2202.56 | 2104.27 | 1851.05 | 1538.9 | 1069.62 | 647.84 | 454.02 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1351.95 | 1757.3 | 2158.8 | 2569.44 | 2849.38 | 2834.59 | 2710.14 | 2467.02 | 2183.86 | 1764.37 | 1398.01 | 1247.2 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 0.99 | 0.97 | 0.9 | 0.74 | 0.54 | 0.37 | 0.27 | 0.31 | 0.52 | 0.85 | 0.98 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 20.17 | 20.43 | 20.72 | 20.93 | 20.99 | 21 | 21 | 21 | 20.99 | 20.87 | 20.47 | 20.12 | (87) |

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

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

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.99 | 0.96 | 0.88 | 0.7 | 0.49 | 0.32 | 0.22 | 0.25 | 0.46 | 0.81 | 0.97 | 0.99 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 19.02 | 19.4 | 19.79 | 20.06 | 20.12 | 20.14 | 20.14 | 20.14 | 20.13 | 20 | 19.46 | 18.96 | (90) |

fLA = Living area ÷ (4) = 0.42 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.5 | 19.83 | 20.18 | 20.42 | 20.49 | 20.5 | 20.5 | 20.5 | 20.49 | 20.36 | 19.88 | 19.44 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.5 | 19.83 | 20.18 | 20.42 | 20.49 | 20.5 | 20.5 | 20.5 | 20.49 | 20.36 | 19.88 | 19.44 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

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

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Utilisation factor for gains, hm:

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (94)m= | 0.99 | 0.96 | 0.88 | 0.71 | 0.51 | 0.34 | 0.24 | 0.27 | 0.48 | 0.82 | 0.97 | 0.99 | (94) |

Useful gains, hmGm , W = (94)m x (84)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (95)m= | 1337.35 | 1689.36 | 1908.36 | 1831.1 | 1457.85 | 976.35 | 646.14 | 677.85 | 1056.32 | 1448.83 | 1357.43 | 1238.1 | (95) |

Monthly average external temperature from Table 8

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |

Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (97)m= | 2601.75 | 2547.71 | 2327.81 | 1935.45 | 1472.3 | 977.46 | 646.23 | 678.06 | 1063.92 | 1635.75 | 2152.59 | 2580.67 | (97) |

Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (98)m= | 940.71 | 576.81 | 312.07 | 75.13 | 10.75 | 0 | 0 | 0 | 0 | 139.07 | 572.51 | 998.87 |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 3625.93 (98)

Space heating requirement in kWh/m²/year 20.37 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1557.3 | 1225.96 | 1256.41 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.99 | 1 | 0.99 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1537.4 | 1220.07 | 1245.44 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 2834.59 | 2710.14 | 2467.02 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 933.98 | 1108.61 | 908.85 | 0 | 0 | 0 | 0 | |



Total = Sum(104)$_{6..8}$ = 2951.44 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6..8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 233.49 | 277.15 | 227.21 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6..8}$ = 737.86 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 4.15 (108)

## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none 0 (301)

Fraction of space heat from community system 1 – (301) = 1 (302)

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

Fraction of heat from Community heat pump 1 (303a)

Fraction of total space heat from Community heat pump (302) x (303a) = 1 (304a)

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| | | | |
|---|---|---|---|
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 3625.93 | |
| Space heat from Community heat pump | (98) x (304a) x (305) x (306) = | 3807.23 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1958.69 | |
| If DHW from community scheme: Water heat from Community heat pump | (64) x (303a) x (305) x (306) = | 2056.62 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 58.64 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 218.63 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f): mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 550.46 | (332) |



## 10b. Fuel costs – Community heating scheme

| | **Fuel** kWh/year | **Fuel Price** (Table 12) | | **Fuel Cost** £/year | |
|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | 4.24 | x 0.01 = | 161.43 | (340a) |
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 87.2 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 28.84 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 72.61 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 470.07 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 0.89 | (357) |
| **SAP rating (section12)** | | 87.65 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | **Energy** kWh/year | **Emission factor** kg CO2/kWh | **Emissions** kg CO2/year |
|---|---|---|---|

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| | | | | | |
|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP)<br>Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | 350 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | 0 | = | 869.53 | (367) |
| Electrical energy for heat distribution | [(313) x | 0.52 | = | 30.43 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | = | 899.96 | (373) |
| CO2 associated with space heating (secondary) | (309) x | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | 899.96 | (376) |
| CO2 associated with space cooling | (315) x | 0.52 | = | 113.47 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | 0.52 | = | 285.69 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | 1299.11 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | 7.3 | (384) |
| **EI rating (section 14)** | | | | 92.19 | (385) |

## 13b. Primary Energy – Community heating scheme

| | | **Energy kWh/year** | **Primary factor** | **P.Energy kWh/year** | |
|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP)<br>Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | 350 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 = | 5143.44 | (367) |
| Electrical energy for heat distribution | [(313) x | | = | 180.02 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | = | 5323.46 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | 5323.46 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | 5323.46 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 = | 671.18 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 = | 1689.9 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | 7684.54 | (383) |

# SAP WorkSheet: New dwelling design stage

## User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | | **Stroma Number:** | |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.3.11 |

## Property Address: Flat 5

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | | Av. Height(m) | | | Volume(m³) | |
|---|---|---|---|---|---|---|---|---|
| Ground floor | 151 | (1a) | x | 2.9 | (2a) | = | 437.9 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 151 | (4) | | | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) | | = | 437.9 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 5 | x 10 = | 50 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |



| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 50 | ÷ (5) = | 0.11 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction<br>*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | 0 | (11) |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.34 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.31 | (21) |

Infiltration rate modified for monthly wind speed

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

Monthly average wind speed from Table 7

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

Wind Factor (22a)m = (22)m ÷ 4

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

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Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.4 | 0.39 | 0.38 | 0.35 | 0.34 | 0.3 | 0.3 | 0.29 | 0.31 | 0.34 | 0.35 | 0.37 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.58 | 0.58 | 0.57 | 0.56 | 0.56 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.58 | 0.58 | 0.57 | 0.56 | 0.56 | 0.54 | 0.54 | 0.54 | 0.55 | 0.56 | 0.56 | 0.57 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 0.91 | x1/[1/( 1.2 )+ 0.04] | | = | 1.04 | | | (27) |
| Windows Type 2 | | | 1.54 | x1/[1/( 1.2 )+ 0.04] | | = | 1.76 | | | (27) |
| Windows Type 3 | | | 0.96 | x1/[1/( 1.2 )+ 0.04] | | = | 1.1 | | | (27) |
| Windows Type 4 | | | 2.76 | x1/[1/( 1.2 )+ 0.04] | | = | 3.16 | | | (27) |
| Walls Type1 | 34.33 | 0 | 34.33 | x | 0.12 | = | 4.12 | | | (29) |
| Walls Type2 | 34.3 | 0 | 34.3 | x | 0.12 | = | 4.12 | | | (29) |
| Walls Type3 | 78.3 | 2.76 | 75.54 | x | 0.12 | = | 9.06 | | | (29) |
| Walls Type4 | 13.34 | 0 | 13.34 | x | 0.12 | = | 1.6 | | | (29) |
| Walls Type5 | 20.88 | 0 | 20.88 | x | 0.11 | = | 2.26 | | | (29) |
| Walls Type6 | 13.54 | 0 | 13.54 | x | 0.11 | = | 1.47 | | | (29) |
| Walls Type7 | 13.34 | 0 | 13.34 | x | 0.11 | = | 1.44 | | | (29) |
| Total area of elements, m² | | | 221.22 | | | | | | | (31) |

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 41.61 (33)

Heat capacity Cm = S(A x k ) ((28)…(30) + (32) + (32a)…(32e) = 0 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

Thermal bridges : S (L x Y) calculated using Appendix K 33.18 (36)

# SAP WorkSheet: New dwelling design stage

*if details of thermal bridging are not known (36) = 0.15 x (31)*

Total fabric heat loss (33) + (36) = 74.8 (37)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 83.82 | 83.37 | 82.93 | 80.86 | 80.47 | 78.67 | 78.67 | 78.34 | 79.37 | 80.47 | 81.25 | 82.07 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 158.61 | 158.16 | 157.72 | 155.65 | 155.27 | 153.47 | 153.47 | 153.13 | 154.16 | 155.27 | 156.05 | 156.87 | |

Average = Sum(39)$_{1...12}$ /12= 155.65 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.05 | 1.05 | 1.04 | 1.03 | 1.03 | 1.02 | 1.02 | 1.01 | 1.02 | 1.03 | 1.03 | 1.04 |

Average = Sum(40)$_{1...12}$ /12= 1.03 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |

## 4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 2.94 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 103.92 (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 114.32 | 110.16 | 106 | 101.85 | 97.69 | 93.53 | 93.53 | 97.69 | 101.85 | 106 | 110.16 | 114.32 |

Total = Sum(44)$_{1...12}$ = 1247.09 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 169.53 | 148.27 | 153 | 133.39 | 127.99 | 110.45 | 102.34 | 117.44 | 118.84 | 138.5 | 151.19 | 164.18 |

Total = Sum(45)$_{1...12}$ = 1635.13 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.43 | 22.24 | 22.95 | 20.01 | 19.2 | 16.57 | 15.35 | 17.62 | 17.83 | 20.78 | 22.68 | 24.63 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 1 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): 0 (48)

Temperature factor from Table 2b 0 (49)

Energy lost from water storage, kWh/year (48) x (49) = 1 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a 4.93 (52)

Temperature factor from Table 2b 0.6 (53)

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.1 (54)

Enter (50) or (54) in (55) 0.1 (55)

# SAP WorkSheet: New dwelling design stage

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 195.82 | 172.02 | 179.29 | 158.83 | 154.28 | 135.89 | 128.64 | 143.73 | 144.29 | 164.79 | 176.63 | 190.47 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 195.82 | 172.02 | 179.29 | 158.83 | 154.28 | 135.89 | 128.64 | 143.73 | 144.29 | 164.79 | 176.63 | 190.47 | |

Output from water heater (annual)$_{1...12}$ — 1944.7 (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 74.98 | 66.11 | 69.48 | 62.36 | 61.17 | 54.73 | 52.64 | 57.66 | 57.53 | 64.66 | 68.28 | 73.2 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating



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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | 176.14 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 76.65 | 68.08 | 55.37 | 41.92 | 31.33 | 26.45 | 28.58 | 37.15 | 49.87 | 63.32 | 73.9 | 78.78 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 480.01 | 484.99 | 472.44 | 445.72 | 411.99 | 380.29 | 359.11 | 354.12 | 366.68 | 393.4 | 427.13 | 458.83 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | 55.55 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | -117.43 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 100.78 | 98.38 | 93.39 | 86.61 | 82.21 | 76.02 | 70.75 | 77.5 | 79.9 | 86.91 | 94.83 | 98.39 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 771.71 | 765.72 | 735.47 | 688.52 | 639.8 | 597.02 | 572.71 | 583.04 | 610.71 | 657.89 | 710.13 | 750.27 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

# SAP WorkSheet: New dwelling design stage

| Orientation: | | Access Factor Table 6d | Area m² | Flux Table 6a | g_ Table 6b | FF Table 6c | Gains (W) | |
|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | 1.54 | 10.63 | 0.9 | 0.9 | 35.81 | (74) |
| North | 0.9x | 1 | 0.96 | 10.63 | 0.9 | 0.9 | 14.88 | (74) |
| North | 0.9x | 1 | 1.54 | 20.32 | 0.9 | 0.9 | 68.44 | (74) |
| North | 0.9x | 1 | 0.96 | 20.32 | 0.9 | 0.9 | 28.44 | (74) |
| North | 0.9x | 1 | 1.54 | 34.53 | 0.9 | 0.9 | 116.3 | (74) |
| North | 0.9x | 1 | 0.96 | 34.53 | 0.9 | 0.9 | 48.33 | (74) |
| North | 0.9x | 1 | 1.54 | 55.46 | 0.9 | 0.9 | 186.8 | (74) |
| North | 0.9x | 1 | 0.96 | 55.46 | 0.9 | 0.9 | 77.63 | (74) |
| North | 0.9x | 1 | 1.54 | 74.72 | 0.9 | 0.9 | 251.64 | (74) |
| North | 0.9x | 1 | 0.96 | 74.72 | 0.9 | 0.9 | 104.58 | (74) |
| North | 0.9x | 1 | 1.54 | 79.99 | 0.9 | 0.9 | 269.39 | (74) |
| North | 0.9x | 1 | 0.96 | 79.99 | 0.9 | 0.9 | 111.95 | (74) |
| North | 0.9x | 1 | 1.54 | 74.68 | 0.9 | 0.9 | 251.51 | (74) |
| North | 0.9x | 1 | 0.96 | 74.68 | 0.9 | 0.9 | 104.52 | (74) |
| North | 0.9x | 1 | 1.54 | 59.25 | 0.9 | 0.9 | 199.54 | (74) |
| North | 0.9x | 1 | 0.96 | 59.25 | 0.9 | 0.9 | 82.93 | (74) |
| North | 0.9x | 1 | 1.54 | 41.52 | 0.9 | 0.9 | 139.83 | (74) |
| North | 0.9x | 1 | 0.96 | 41.52 | 0.9 | 0.9 | 58.11 | (74) |
| North | 0.9x | 1 | 1.54 | 24.19 | 0.9 | 0.9 | 81.47 | (74) |
| North | 0.9x | 1 | 0.96 | 24.19 | 0.9 | 0.9 | 33.86 | (74) |
| North | 0.9x | 1 | 1.54 | 13.12 | 0.9 | 0.9 | 44.18 | (74) |
| North | 0.9x | 1 | 0.96 | 13.12 | 0.9 | 0.9 | 18.36 | (74) |
| North | 0.9x | 1 | 1.54 | 8.86 | 0.9 | 0.9 | 29.86 | (74) |
| North | 0.9x | 1 | 0.96 | 8.86 | 0.9 | 0.9 | 12.41 | (74) |
| South | 0.9x | 1 | 0.91 | 46.75 | 0.9 | 0.9 | 155.07 | (78) |
| South | 0.9x | 1 | 0.91 | 76.57 | 0.9 | 0.9 | 253.97 | (78) |
| South | 0.9x | 1 | 0.91 | 97.53 | 0.9 | 0.9 | 323.51 | (78) |
| South | 0.9x | 1 | 0.91 | 110.23 | 0.9 | 0.9 | 365.64 | (78) |
| South | 0.9x | 1 | 0.91 | 114.87 | 0.9 | 0.9 | 381.02 | (78) |
| South | 0.9x | 1 | 0.91 | 110.55 | 0.9 | 0.9 | 366.68 | (78) |
| South | 0.9x | 1 | 0.91 | 108.01 | 0.9 | 0.9 | 358.27 | (78) |
| South | 0.9x | 1 | 0.91 | 104.89 | 0.9 | 0.9 | 347.93 | (78) |
| South | 0.9x | 1 | 0.91 | 101.89 | 0.9 | 0.9 | 337.95 | (78) |
| South | 0.9x | 1 | 0.91 | 82.59 | 0.9 | 0.9 | 273.93 | (78) |
| South | 0.9x | 1 | 0.91 | 55.42 | 0.9 | 0.9 | 183.82 | (78) |
| South | 0.9x | 1 | 0.91 | 40.4 | 0.9 | 0.9 | 134 | (78) |
| West | 0.9x | 1 | 2.76 | 19.64 | 0.9 | 0.9 | 39.52 | (80) |
| West | 0.9x | 1 | 2.76 | 38.42 | 0.9 | 0.9 | 77.3 | (80) |
| West | 0.9x | 1 | 2.76 | 63.27 | 0.9 | 0.9 | 127.31 | (80) |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| West | 0.9x | 1 | x | 2.76 | x | 92.28 | x | 0.9 | x | 0.9 | = | 185.67 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 113.09 | x | 0.9 | x | 0.9 | = | 227.55 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 115.77 | x | 0.9 | x | 0.9 | = | 232.93 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 110.22 | x | 0.9 | x | 0.9 | = | 221.76 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 94.68 | x | 0.9 | x | 0.9 | = | 190.49 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 73.59 | x | 0.9 | x | 0.9 | = | 148.06 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 45.59 | x | 0.9 | x | 0.9 | = | 91.73 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 24.49 | x | 0.9 | x | 0.9 | = | 49.27 | (80) |
| West | 0.9x | 1 | x | 2.76 | x | 16.15 | x | 0.9 | x | 0.9 | = | 32.5 | (80) |

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 245.29 | 428.16 | 615.45 | 815.75 | 964.79 | 980.96 | 936.07 | 820.89 | 683.95 | 480.99 | 295.63 | 208.76 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1016.99 | 1193.88 | 1350.92 | 1504.26 | 1604.59 | 1577.98 | 1508.77 | 1403.93 | 1294.66 | 1138.88 | 1005.76 | 959.03 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 0.99 | 0.98 | 0.92 | 0.8 | 0.6 | 0.44 | 0.5 | 0.75 | 0.95 | 0.99 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.96 | 20.14 | 20.39 | 20.69 | 20.9 | 20.98 | 21 | 21 | 20.94 | 20.66 | 20.26 | 19.93 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 20.04 | 20.04 | 20.05 | 20.06 | 20.06 | 20.07 | 20.07 | 20.07 | 20.07 | 20.06 | 20.06 | 20.05 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 1 | 0.99 | 0.97 | 0.9 | 0.74 | 0.52 | 0.35 | 0.4 | 0.68 | 0.93 | 0.99 | 1 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.66 | 18.92 | 19.28 | 19.7 | 19.96 | 20.06 | 20.07 | 20.07 | 20.02 | 19.68 | 19.1 | 18.63 | (90) |

fLA = Living area ÷ (4) = 0.33 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.09 | 19.32 | 19.64 | 20.03 | 20.27 | 20.36 | 20.38 | 20.38 | 20.33 | 20.01 | 19.48 | 19.06 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.09 | 19.32 | 19.64 | 20.03 | 20.27 | 20.36 | 20.38 | 20.38 | 20.33 | 20.01 | 19.48 | 19.06 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.99 | 0.99 | 0.96 | 0.9 | 0.76 | 0.55 | 0.38 | 0.43 | 0.7 | 0.93 | 0.99 | 1 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1010.7 | 1176.56 | 1301.84 | 1352.13 | 1215.68 | 868.68 | 577.77 | 605.56 | 904.91 | 1059.23 | 992.09 | 954.58 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 2346.59 | 2280.68 | 2073.04 | 1731.98 | 1331.04 | 884.65 | 579.53 | 608.88 | 960.2 | 1460.32 | 1932.28 | 2331.13 | (97) |

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Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (98)m= | 993.91 | 741.97 | 573.77 | 273.49 | 85.82 | 0 | 0 | 0 | 0 | 298.41 | 676.94 | 1024.16 |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 4668.47 (98)

Space heating requirement in kWh/m²/year 30.92 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1442.6 | 1135.66 | 1163.82 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.88 | 0.94 | 0.91 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1273.45 | 1067.05 | 1064.85 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 1577.98 | 1508.77 | 1403.93 | 0 | 0 | 0 | 0 | (103) |

*Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m*
set (104)m to zero if (104)m < 3 × (98)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (104)m= | 0 | 0 | 0 | 0 | 0 | 219.26 | 328.64 | 252.28 | 0 | 0 | 0 | 0 |

Total = Sum(104)$_{6...8}$ = 800.18 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 54.82 | 82.16 | 63.07 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 200.05 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 1.32 (108)



## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community heat pump | | 1 | (303a) |
| Fraction of total space heat from Community heat pump | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 4668.47 | |
| Space heat from Community heat pump | (98) x (304a) x (305) x (306) = | 4901.89 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |

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**Water heating**

| | | | |
|---|---|---|---|
| Annual water heating requirement | | 1944.7 | |
| If DHW from community scheme: | | | |
| Water heat from Community heat pump | (64) x (303a) x (305) x (306) = | 2041.93 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 69.44 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 59.27 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f): | | | |
| mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 541.48 | (332) |

## 10b. Fuel costs – Community heating scheme

| | Fuel kWh/year | | Fuel Price (Table 12) | | Fuel Cost £/year | |
|---|---|---|---|---|---|---|
| Space heating from CHP | (307a) | x | 4.24 | x 0.01 = | 207.84 | (340a) |
| Water heating from CHP | (310a) | x | 4.24 | x 0.01 = | 86.58 | (342a) |
| | | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | | 13.19 | x 0.01 = | 7.82 | (348) |
| Pumps and fans | (331) | | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | | 13.19 | x 0.01 = | 71.42 | (350) |
| Additional standing charges (Table 12) | | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | | 493.66 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 1.06 | (357) |
| **SAP rating (section12)** | | 85.24 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | Energy kWh/year | Emission factor kg CO2/kWh | | Emissions kg CO2/year | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1029.67 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 36.04 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1065.71 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |

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# SAP WorkSheet: New dwelling design stage

| | | | | | |
|---|---|---|---|---|---|
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | 1065.71 | (376) |
| CO2 associated with space cooling | (315) x | 0.52 | = | 30.76 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | 0.52 | = | 281.03 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | 1377.5 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | 9.12 | (384) |
| **EI rating (section 14)** | | | | 90.58 | (385) |

## 13b. Primary Energy – Community heating scheme

| | | Energy kWh/year | Primary factor | | P.Energy kWh/year | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 6090.72 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 213.18 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 6303.9 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 6303.9 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | | 6303.9 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = | 181.97 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = | 1662.35 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | | 8148.22 | (383) |

# SAP WorkSheet: New dwelling design stage

## User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | | **Stroma Number:** | |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.3.11 |

## Property Address: Flat 6

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 167 | (1a) x | 2.9 | (2a) = | 484.3 | (3a) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 167 | (4) | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 484.3 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 4 | x 10 = | 40 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |



| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 40 | ÷ (5) = | 0.08 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction<br>*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | 0 | (11) |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.31 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.28 | (21) |

Infiltration rate modified for monthly wind speed

Monthly average wind speed from Table 7

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

Wind Factor (22a)m = (22)m ÷ 4

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

# SAP WorkSheet: New dwelling design stage

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.36 | 0.36 | 0.35 | 0.31 | 0.31 | 0.27 | 0.27 | 0.26 | 0.28 | 0.31 | 0.32 | 0.33 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.57 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.56 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.57 | 0.56 | 0.56 | 0.55 | 0.55 | 0.54 | 0.54 | 0.53 | 0.54 | 0.55 | 0.55 | 0.56 | (25) |



## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 3.43 | x1/[1/( 1.2 )+ 0.04] | | = | 3.93 | | | (27) |
| Windows Type 2 | | | 1.54 | x1/[1/( 1.2 )+ 0.04] | | = | 1.76 | | | (27) |
| Windows Type 3 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 4 | | | 0.91 | x1/[1/( 1.2 )+ 0.04] | | = | 1.04 | | | (27) |
| Windows Type 5 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Windows Type 6 | | | 1.26 | x1/[1/( 1.2 )+ 0.04] | | = | 1.44 | | | (27) |
| Windows Type 7 | | | 2.8 | x1/[1/( 1.2 )+ 0.04] | | = | 3.21 | | | (27) |
| Walls Type1 | 28.13 | 0 | 28.13 | x | 0.12 | = | 3.38 | | | (29) |
| Walls Type2 | 63.8 | 4.9 | 58.9 | x | 0.12 | = | 7.07 | | | (29) |
| Walls Type3 | 21.46 | 0 | 21.46 | x | 0.11 | = | 2.32 | | | (29) |
| Walls Type4 | 28.13 | 0 | 28.13 | x | 0.12 | = | 3.38 | | | (29) |
| Roof | 72 | 0 | 72 | x | 0.18 | = | 12.96 | | | (30) |
| Total area of elements, m² | | | 237.46 | | | | | | | (31) |

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*

*** include the areas on both sides of internal walls and partitions*

Fabric heat loss, W/K = S (A x U) (26)…(30) + (32) = 61.4 (33)

Heat capacity Cm = S(A x k ) ((28)…(30) + (32) + (32a)…(32e) = 648 (34)

Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K Indicative Value: Medium 250 (35)

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f*

*can be used instead of a detailed calculation.*

Thermal bridges : S (L x Y) calculated using Appendix K — 35.62 (36)

*if details of thermal bridging are not known (36) = 0.15 x (31)*

Total fabric heat loss — (33) + (36) = — 97.02 (37)

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 90.43 | 90.02 | 89.62 | 87.74 | 87.39 | 85.75 | 85.75 | 85.44 | 86.38 | 87.39 | 88.1 | 88.84 | (38) |

Heat transfer coefficient, W/K — (39)m = (37) + (38)m

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 187.45 | 187.04 | 186.64 | 184.76 | 184.41 | 182.77 | 182.77 | 182.47 | 183.4 | 184.41 | 185.12 | 185.86 |

Average = Sum(39)$_{1…12}$ /12= 184.76 (39)

Heat loss parameter (HLP), $W/m^2K$ — (40)m = (39)m ÷ (4)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.12 | 1.12 | 1.12 | 1.11 | 1.1 | 1.09 | 1.09 | 1.09 | 1.1 | 1.1 | 1.11 | 1.11 |

Average = Sum(40)$_{1…12}$ /12= 1.11 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |

## 4. Water heating energy requirement: kWh/year:



Assumed occupancy, N — 2.96 (42)

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)

if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 — 104.47 (43)

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 114.91 | 110.73 | 106.55 | 102.38 | 98.2 | 94.02 | 94.02 | 98.2 | 102.38 | 106.55 | 110.73 | 114.91 |

Total = Sum(44)$_{1…12}$ = 1253.58 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 170.41 | 149.04 | 153.8 | 134.09 | 128.66 | 111.02 | 102.88 | 118.05 | 119.46 | 139.22 | 151.97 | 165.03 |

Total = Sum(45)$_{1…12}$ = 1643.65 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.56 | 22.36 | 23.07 | 20.11 | 19.3 | 16.65 | 15.43 | 17.71 | 17.92 | 20.88 | 22.8 | 24.76 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel — 1 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)

Otherwise if no stored hot water (this includes instantaneous combi boilers) enter '0' in (47)

Water storage loss:

a) If manufacturer's declared loss factor is known (kWh/day): — 0 (48)

Temperature factor from Table 2b — 0 (49)

Energy lost from water storage, kWh/year — (48) x (49) = — 1 (50)

b) If manufacturer's declared cylinder loss factor is not known:

Hot water storage loss factor from Table 2 (kWh/litre/day) — 0.03 (51)

If community heating see section 4.3

Volume factor from Table 2a — 4.93 (52)

Temperature factor from Table 2b — 0.6 (53)

# SAP WorkSheet: New dwelling design stage

Energy lost from water storage, kWh/year (47) x (51) x (52) x (53) = 0.1 (54)

Enter (50) or (54) in (55) 0.1 (55)

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 196.7 | 172.79 | 180.09 | 159.53 | 154.95 | 136.47 | 129.17 | 144.35 | 144.91 | 165.52 | 177.42 | 191.33 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 196.7 | 172.79 | 180.09 | 159.53 | 154.95 | 136.47 | 129.17 | 144.35 | 144.91 | 165.52 | 177.42 | 191.33 |

Output from water heater (annual)$_{1...12}$ 1953.22 (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 75.27 | 66.37 | 69.75 | 62.59 | 61.39 | 54.92 | 52.82 | 57.86 | 57.73 | 64.9 | 68.54 | 73.48 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating



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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | 177.51 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 75.44 | 67 | 54.49 | 41.25 | 30.84 | 26.03 | 28.13 | 36.57 | 49.08 | 62.32 | 72.73 | 77.54 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 505.19 | 510.43 | 497.22 | 469.1 | 433.6 | 400.23 | 377.94 | 372.7 | 385.91 | 414.03 | 449.53 | 482.9 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | 55.71 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | -118.34 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 101.17 | 98.76 | 93.75 | 86.93 | 82.51 | 76.28 | 70.99 | 77.77 | 80.18 | 87.23 | 95.2 | 98.77 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 796.68 | 791.08 | 760.34 | 712.17 | 661.83 | 617.43 | 591.94 | 601.92 | 630.05 | 678.46 | 732.34 | 774.08 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

# SAP WorkSheet: New dwelling design stage

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 1.54 | x | 10.63 | x | 0.9 | x | 0.9 | = | 35.81 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 10.63 | x | 0.9 | x | 0.9 | = | 29.3 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 10.63 | x | 0.9 | x | 0.9 | = | 65.11 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 20.32 | x | 0.9 | x | 0.9 | = | 68.44 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 20.32 | x | 0.9 | x | 0.9 | = | 56 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 20.32 | x | 0.9 | x | 0.9 | = | 124.44 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 34.53 | x | 0.9 | x | 0.9 | = | 116.3 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 34.53 | x | 0.9 | x | 0.9 | = | 95.15 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 34.53 | x | 0.9 | x | 0.9 | = | 211.45 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 55.46 | x | 0.9 | x | 0.9 | = | 186.8 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 55.46 | x | 0.9 | x | 0.9 | = | 152.84 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 55.46 | x | 0.9 | x | 0.9 | = | 339.64 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.72 | x | 0.9 | x | 0.9 | = | 251.64 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 74.72 | x | 0.9 | x | 0.9 | = | 205.89 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 74.72 | x | 0.9 | x | 0.9 | = | 457.53 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 79.99 | x | 0.9 | x | 0.9 | = | 269.39 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 79.99 | x | 0.9 | x | 0.9 | = | 220.41 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 79.99 | x | 0.9 | x | 0.9 | = | 489.8 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.68 | x | 0.9 | x | 0.9 | = | 251.51 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 74.68 | x | 0.9 | x | 0.9 | = | 205.78 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 74.68 | x | 0.9 | x | 0.9 | = | 457.29 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 59.25 | x | 0.9 | x | 0.9 | = | 199.54 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 59.25 | x | 0.9 | x | 0.9 | = | 163.26 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 59.25 | x | 0.9 | x | 0.9 | = | 362.8 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 41.52 | x | 0.9 | x | 0.9 | = | 139.83 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 41.52 | x | 0.9 | x | 0.9 | = | 114.4 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 41.52 | x | 0.9 | x | 0.9 | = | 254.23 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 24.19 | x | 0.9 | x | 0.9 | = | 81.47 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 24.19 | x | 0.9 | x | 0.9 | = | 66.66 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 24.19 | x | 0.9 | x | 0.9 | = | 148.13 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 13.12 | x | 0.9 | x | 0.9 | = | 44.18 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 13.12 | x | 0.9 | x | 0.9 | = | 36.15 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 13.12 | x | 0.9 | x | 0.9 | = | 80.33 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 8.86 | x | 0.9 | x | 0.9 | = | 29.86 | (74) |
| North | 0.9x | 1 | x | 1.26 | x | 8.86 | x | 0.9 | x | 0.9 | = | 24.43 | (74) |
| North | 0.9x | 1 | x | 2.8 | x | 8.86 | x | 0.9 | x | 0.9 | = | 54.28 | (74) |
| East | 0.9x | 1 | x | 2.8 | x | 19.64 | x | 0.9 | x | 0.9 | = | 40.09 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 38.42 | x | 0.9 | x | 0.9 | = | 78.42 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 63.27 | x | 0.9 | x | 0.9 | = | 129.15 | (76) |

# SAP WorkSheet: New dwelling design stage

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 1 | x | 2.8 | x | 92.28 | x | 0.9 | x | 0.9 | = | 188.36 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 113.09 | x | 0.9 | x | 0.9 | = | 230.84 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 115.77 | x | 0.9 | x | 0.9 | = | 236.31 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 110.22 | x | 0.9 | x | 0.9 | = | 224.98 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 94.68 | x | 0.9 | x | 0.9 | = | 193.25 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 73.59 | x | 0.9 | x | 0.9 | = | 150.21 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 45.59 | x | 0.9 | x | 0.9 | = | 93.06 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 24.49 | x | 0.9 | x | 0.9 | = | 49.99 | (76) |
| East | 0.9x | 1 | x | 2.8 | x | 16.15 | x | 0.9 | x | 0.9 | = | 32.97 | (76) |
| South | 0.9x | 1 | x | 3.43 | x | 46.75 | x | 0.9 | x | 0.9 | = | 116.9 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 46.75 | x | 0.9 | x | 0.9 | = | 31.01 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 46.75 | x | 0.9 | x | 0.9 | = | 95.43 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 76.57 | x | 0.9 | x | 0.9 | = | 191.46 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 76.57 | x | 0.9 | x | 0.9 | = | 50.79 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 76.57 | x | 0.9 | x | 0.9 | = | 156.29 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 97.53 | x | 0.9 | x | 0.9 | = | 243.88 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 97.53 | x | 0.9 | x | 0.9 | = | 64.7 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 97.53 | x | 0.9 | x | 0.9 | = | 199.09 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 110.23 | x | 0.9 | x | 0.9 | = | 275.64 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.23 | x | 0.9 | x | 0.9 | = | 73.13 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 110.23 | x | 0.9 | x | 0.9 | = | 225.01 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 114.87 | x | 0.9 | x | 0.9 | = | 287.23 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 114.87 | x | 0.9 | x | 0.9 | = | 76.2 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 114.87 | x | 0.9 | x | 0.9 | = | 234.47 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 110.55 | x | 0.9 | x | 0.9 | = | 276.42 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 110.55 | x | 0.9 | x | 0.9 | = | 73.34 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 110.55 | x | 0.9 | x | 0.9 | = | 225.65 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 108.01 | x | 0.9 | x | 0.9 | = | 270.08 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 108.01 | x | 0.9 | x | 0.9 | = | 71.65 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 108.01 | x | 0.9 | x | 0.9 | = | 220.47 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 104.89 | x | 0.9 | x | 0.9 | = | 262.29 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 104.89 | x | 0.9 | x | 0.9 | = | 69.59 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 104.89 | x | 0.9 | x | 0.9 | = | 214.11 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 101.89 | x | 0.9 | x | 0.9 | = | 254.76 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 101.89 | x | 0.9 | x | 0.9 | = | 67.59 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 101.89 | x | 0.9 | x | 0.9 | = | 207.97 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 82.59 | x | 0.9 | x | 0.9 | = | 206.5 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 82.59 | x | 0.9 | x | 0.9 | = | 54.79 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 82.59 | x | 0.9 | x | 0.9 | = | 168.57 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 55.42 | x | 0.9 | x | 0.9 | = | 138.57 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 55.42 | x | 0.9 | x | 0.9 | = | 36.76 | (78) |

# SAP WorkSheet: New dwelling design stage

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 2.8 | x | 55.42 | x | 0.9 | x | 0.9 | = | 113.12 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 40.4 | x | 0.9 | x | 0.9 | = | 101.01 | (78) |
| South | 0.9x | 1 | x | 0.91 | x | 40.4 | x | 0.9 | x | 0.9 | = | 26.8 | (78) |
| South | 0.9x | 1 | x | 2.8 | x | 40.4 | x | 0.9 | x | 0.9 | = | 82.46 | (78) |

Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 413.67 | 725.84 | 1059.72 | 1441.42 | 1743.81 | 1791.32 | 1701.76 | 1464.84 | 1188.99 | 819.17 | 499.09 | 351.81 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1210.35 | 1516.91 | 1820.06 | 2153.59 | 2405.64 | 2408.75 | 2293.71 | 2066.75 | 1819.04 | 1497.64 | 1231.43 | 1125.89 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) 21 (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 0.99 | 0.95 | 0.85 | 0.67 | 0.48 | 0.35 | 0.4 | 0.66 | 0.92 | 0.99 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.91 | 20.14 | 20.45 | 20.77 | 20.95 | 20.99 | 21 | 21 | 20.96 | 20.7 | 20.23 | 19.87 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 19.98 | 19.98 | 19.99 | 20 | 20 | 20.01 | 20.01 | 20.01 | 20 | 20 | 19.99 | 19.99 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.99 | 0.98 | 0.94 | 0.82 | 0.61 | 0.41 | 0.27 | 0.32 | 0.58 | 0.89 | 0.98 | 1 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.54 | 18.88 | 19.32 | 19.75 | 19.95 | 20 | 20 | 20.01 | 19.98 | 19.67 | 19.02 | 18.49 | (90) |

fLA = Living area ÷ (4) = 0.43 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 19.13 | 19.42 | 19.8 | 20.19 | 20.38 | 20.43 | 20.43 | 20.43 | 20.4 | 20.11 | 19.54 | 19.08 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 19.13 | 19.42 | 19.8 | 20.19 | 20.38 | 20.43 | 20.43 | 20.43 | 20.4 | 20.11 | 19.54 | 19.08 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.99 | 0.98 | 0.94 | 0.82 | 0.64 | 0.44 | 0.3 | 0.35 | 0.61 | 0.9 | 0.98 | 0.99 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1200.65 | 1482.28 | 1704.55 | 1776.13 | 1530.06 | 1056.52 | 699.32 | 733.51 | 1113.46 | 1343.16 | 1208.52 | 1119.4 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 2780.12 | 2716.11 | 2483.05 | 2086.37 | 1600.17 | 1064.88 | 700.31 | 735.63 | 1155.49 | 1753.67 | 2302.75 | 2765.46 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1175.13 | 829.13 | 579.21 | 223.37 | 52.16 | 0 | 0 | 0 | 0 | 305.42 | 787.84 | 1224.67 | |

Total per year (kWh/year) = $Sum(98)_{1...5,9...12}$ = 5176.94 (98)

Space heating requirement in kWh/m²/year 31 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 1718.02 | 1352.49 | 1386.74 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.94 | 0.97 | 0.96 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1622.23 | 1316.1 | 1325.18 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 2408.75 | 2293.71 | 2066.75 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 566.29 | 727.34 | 551.73 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 1845.37 (104)

Cooled fraction — f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 141.57 | 181.83 | 137.93 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 461.34 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 2.76 (108)



## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community heat pump | | 1 | (303a) |
| Fraction of total space heat from Community heat pump | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 5176.94 | |
| Space heat from Community heat pump | (98) x (304a) x (305) x (306) = | 5435.79 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1953.22 | |
| If DHW from community scheme: Water heat from Community heat pump | (64) x (303a) x (305) x (306) = | 2050.88 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 74.87 | (313) |

# SAP WorkSheet: New dwelling design stage

| | | | |
|---|---|---|---|
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 136.69 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f):<br>mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 532.91 | (332) |

## 10b. Fuel costs – Community heating scheme

| | **Fuel**<br>kWh/year | | **Fuel Price**<br>(Table 12) | | **Fuel Cost**<br>£/year | |
|---|---|---|---|---|---|---|
| Space heating from CHP | (307a) | x | 4.24 | x 0.01 = | 230.48 | (340a) |
| Water heating from CHP | (310a) | x | 4.24 | x 0.01 = | 86.96 | (342a) |
| | | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | | 13.19 | x 0.01 = | 18.03 | (348) |
| Pumps and fans | (331) | | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | | 13.19 | x 0.01 = | 70.29 | (350) |
| Additional standing charges (Table 12) | | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | | 525.76 | (355) |



## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 1.04 | (357) |
| **SAP rating (section12)** | | 85.47 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | **Energy**<br>**kWh/year** | **Emission factor**<br>**kg CO2/kWh** | | **Emissions**<br>**kg CO2/year** | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP)<br>Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1110.17 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 38.86 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1149.02 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1149.02 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 70.94 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 276.58 | (379) |

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| | | | | | |
|---|---|---|---|---|---|
| **Total CO2, kg/year** | sum of (376)…(382) = | | | 1496.54 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | 8.96 | (384) |
| **EI rating (section 14)** | | | | 90.54 | (385) |

## 13b. Primary Energy – Community heating scheme

| | | Energy kWh/year | Primary factor | P.Energy kWh/year | |
|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | 350 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = 6566.87 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = 229.84 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = 6796.71 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | 6796.71 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | 6796.71 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = 419.65 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = 1636.03 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | 8852.39 | (383) |

# SAP WorkSheet: New dwelling design stage

## User Details:

**Assessor Name:** 

**Stroma Number:** 

**Software Name:** Stroma FSAP 2012

**Software Version:** Version: 1.0.3.11

## Property Address: Flat 7

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | Av. Height(m) | | Volume(m³) | |
|---|---|---|---|---|---|---|
| Ground floor | 243 | (1a) x | 2.9 | (2a) = | 704.7 | (3a) |
| First floor | 28 | (1b) x | 2.75 | (2b) = | 77 | (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 271 | (4) | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) = | 781.7 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 5 | x 10 = | 50 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |



| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 50 | ÷ (5) = | 0.06 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |
| *if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35* | | | |
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.29 | (18) |
| *Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used* | | | |
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.27 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

# SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.34 | 0.33 | 0.33 | 0.29 | 0.29 | 0.25 | 0.25 | 0.25 | 0.27 | 0.29 | 0.3 | 0.31 |

*Calculate effective air change rate for the applicable case*

| | | |
|---|---|---|
| If mechanical ventilation: | 0 | (23a) |
| If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) | 0 | (23b) |
| If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = | 0 | (23c) |

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside

if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft

if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.56 | 0.56 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.56 | 0.56 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (25) |

## 3. Heat losses and heat loss parameter:

| **ELEMENT** | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 2.1 | x | 0.8 | = | 1.68 | | | (26) |
| Windows Type 1 | | | 0.98 | x1/[1/( 1.2 )+ 0.04] | | = | 1.12 | | | (27) |
| Windows Type 2 | | | 4 | x1/[1/( 1.2 )+ 0.04] | | = | 4.58 | | | (27) |
| Windows Type 3 | | | 3.3 | x1/[1/( 1.2 )+ 0.04] | | = | 3.78 | | | (27) |
| Windows Type 4 | | | 3.1 | x1/[1/( 1.2 )+ 0.04] | | = | 3.55 | | | (27) |
| Windows Type 5 | | | 2.1 | x1/[1/( 1.2 )+ 0.04] | | = | 2.4 | | | (27) |
| Windows Type 6 | | | 0.8 | x1/[1/( 1.2 )+ 0.04] | | = | 0.92 | | | (27) |
| Windows Type 7 | | | 1.54 | x1/[1/( 1.2 )+ 0.04] | | = | 1.76 | | | (27) |
| Rooflights | | | 1 | x1/[1/(1.3) + 0.04] | | = | 1.3 | | | (27b) |
| Walls Type1 | 44.77 | 6.28 | 38.49 | x | 0.12 | = | 4.62 | | | (29) |
| Walls Type2 | 69.02 | 2.1 | 66.92 | x | 0.12 | = | 8.03 | | | (29) |
| Walls Type3 | 45.53 | 8.5 | 37.03 | x | 0.12 | = | 4.44 | | | (29) |
| Walls Type4 | 13.34 | 0 | 13.34 | x | 0.11 | = | 1.44 | | | (29) |
| Walls Type5 | 21.46 | 2.94 | 18.52 | x | 0.11 | = | 2.01 | | | (29) |
| Walls Type6 | 69.02 | 4 | 65.02 | x | 0.12 | = | 7.8 | | | (29) |
| Walls Type7 | 9.86 | 0 | 9.86 | x | 0.11 | = | 1.07 | | | (29) |
| Roof Type1 | 28 | 2 | 26 | x | 0.18 | = | 4.68 | | | (30) |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Roof Type2 | 87 | 2 | 85 | x | 0.18 | = | 15.3 | | (30) |
| Total area of elements, m² | | | 386 | | | | | | (31) |

** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 78.42 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 0 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 57.9 | (36) |

*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 136.32 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 143.96 | 143.38 | 142.81 | 140.13 | 139.63 | 137.3 | 137.3 | 136.87 | 138.2 | 139.63 | 140.64 | 141.7 | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 280.28 | 279.69 | 279.12 | 276.45 | 275.94 | 273.61 | 273.61 | 273.18 | 274.51 | 275.94 | 276.96 | 278.02 | |

Average = Sum(39)1…12 /12= 276.44 (39)

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.03 | 1.03 | 1.03 | 1.02 | 1.02 | 1.01 | 1.01 | 1.01 | 1.01 | 1.02 | 1.02 | 1.03 | |

Average = Sum(40)1…12 /12= 1.02 (40)

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |

DRAFT

## 4. Water heating energy requirement: kWh/year:

Assumed occupancy, N 3.09 (42)
if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 107.69 (43)
*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)* | | | | | | | | | | | | | |
| (44)m= | 118.46 | 114.15 | 109.84 | 105.53 | 101.23 | 96.92 | 96.92 | 101.23 | 105.53 | 109.84 | 114.15 | 118.46 | |

Total = Sum(44)1…12 = 1292.26 (44)

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 175.67 | 153.64 | 158.54 | 138.22 | 132.63 | 114.45 | 106.05 | 121.7 | 123.15 | 143.52 | 156.66 | 170.13 | |

Total = Sum(45)1…12 = 1694.35 (45)

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 26.35 | 23.05 | 23.78 | 20.73 | 19.89 | 17.17 | 15.91 | 18.25 | 18.47 | 21.53 | 23.5 | 25.52 | (46) |

Water storage loss:

Storage volume (litres) including any solar or WWHRS storage within same vessel 1 (47)

If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter ‘0’ in (47)
Water storage loss:

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| | | | | |
|---|---|---|---|---|
| a) If manufacturer's declared loss factor is known (kWh/day): | | | 0 | (48) |
| Temperature factor from Table 2b | | | 0 | (49) |
| Energy lost from water storage, kWh/year | (48) x (49) = | | 1 | (50) |
| b) If manufacturer's declared cylinder loss factor is not known: | | | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | | | 0.03 | (51) |
| If community heating see section 4.3 | | | | |
| Volume factor from Table 2a | | | 4.93 | (52) |
| Temperature factor from Table 2b | | | 0.6 | (53) |
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | | 0.1 | (54) |
| Enter (50) or (54) in (55) | | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 — 0 (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 201.96 | 177.39 | 184.84 | 163.67 | 158.92 | 139.89 | 132.34 | 147.99 | 148.59 | 169.81 | 182.11 | 196.42 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 201.96 | 177.39 | 184.84 | 163.67 | 158.92 | 139.89 | 132.34 | 147.99 | 148.59 | 169.81 | 182.11 | 196.42 |

Output from water heater (annual)$_{1...12}$ — 2003.92 (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 77.02 | 67.89 | 71.33 | 63.97 | 62.71 | 56.06 | 53.87 | 59.07 | 58.96 | 66.33 | 70.1 | 75.18 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | 185.65 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 105.02 | 93.28 | 75.86 | 57.43 | 42.93 | 36.24 | 39.16 | 50.9 | 68.32 | 86.75 | 101.25 | 107.94 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 648.26 | 654.99 | 638.03 | 601.95 | 556.39 | 513.58 | 484.97 | 478.25 | 495.2 | 531.29 | 576.84 | 619.66 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | 56.66 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | -123.77 | (71) |

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 103.52 | 101.03 | 95.87 | 88.84 | 84.29 | 77.87 | 72.41 | 79.4 | 81.88 | 89.15 | 97.36 | 101.04 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 975.34 | 967.84 | 928.3 | 866.77 | 802.15 | 746.23 | 715.09 | 727.1 | 763.95 | 825.74 | 894 | 947.18 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 0.8 | x | 10.63 | x | 0.9 | x | 0.9 | = | 24.81 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 10.63 | x | 0.9 | x | 0.9 | = | 23.88 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 20.32 | x | 0.9 | x | 0.9 | = | 47.4 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 20.32 | x | 0.9 | x | 0.9 | = | 45.63 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 34.53 | x | 0.9 | x | 0.9 | = | 80.55 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 34.53 | x | 0.9 | x | 0.9 | = | 77.53 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 55.46 | x | 0.9 | x | 0.9 | = | 129.39 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 55.46 | x | 0.9 | x | 0.9 | = | 124.54 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 74.72 | x | 0.9 | x | 0.9 | = | 174.3 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.72 | x | 0.9 | x | 0.9 | = | 167.76 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 79.99 | x | 0.9 | x | 0.9 | = | 186.59 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 79.99 | x | 0.9 | x | 0.9 | = | 179.59 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 74.68 | x | 0.9 | x | 0.9 | = | 174.21 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 74.68 | x | 0.9 | x | 0.9 | = | 167.67 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 59.25 | x | 0.9 | x | 0.9 | = | 138.21 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 59.25 | x | 0.9 | x | 0.9 | = | 133.03 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 41.52 | x | 0.9 | x | 0.9 | = | 96.85 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 41.52 | x | 0.9 | x | 0.9 | = | 93.22 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 24.19 | x | 0.9 | x | 0.9 | = | 56.43 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 24.19 | x | 0.9 | x | 0.9 | = | 54.31 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 13.12 | x | 0.9 | x | 0.9 | = | 30.6 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 13.12 | x | 0.9 | x | 0.9 | = | 29.45 | (74) |
| North | 0.9x | 1 | x | 0.8 | x | 8.86 | x | 0.9 | x | 0.9 | = | 20.68 | (74) |
| North | 0.9x | 1 | x | 1.54 | x | 8.86 | x | 0.9 | x | 0.9 | = | 19.9 | (74) |
| East | 0.9x | 1 | x | 4 | x | 19.64 | x | 0.9 | x | 0.9 | = | 57.27 | (76) |
| East | 0.9x | 1 | x | 4 | x | 38.42 | x | 0.9 | x | 0.9 | = | 112.03 | (76) |
| East | 0.9x | 1 | x | 4 | x | 63.27 | x | 0.9 | x | 0.9 | = | 184.5 | (76) |
| East | 0.9x | 1 | x | 4 | x | 92.28 | x | 0.9 | x | 0.9 | = | 269.09 | (76) |
| East | 0.9x | 1 | x | 4 | x | 113.09 | x | 0.9 | x | 0.9 | = | 329.78 | (76) |
| East | 0.9x | 1 | x | 4 | x | 115.77 | x | 0.9 | x | 0.9 | = | 337.59 | (76) |

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| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 1 | x | 4 | x | 110.22 | x | 0.9 | x | 0.9 | = | 321.4 | (76) |
| East | 0.9x | 1 | x | 4 | x | 94.68 | x | 0.9 | x | 0.9 | = | 276.07 | (76) |
| East | 0.9x | 1 | x | 4 | x | 73.59 | x | 0.9 | x | 0.9 | = | 214.59 | (76) |
| East | 0.9x | 1 | x | 4 | x | 45.59 | x | 0.9 | x | 0.9 | = | 132.94 | (76) |
| East | 0.9x | 1 | x | 4 | x | 24.49 | x | 0.9 | x | 0.9 | = | 71.41 | (76) |
| East | 0.9x | 1 | x | 4 | x | 16.15 | x | 0.9 | x | 0.9 | = | 47.1 | (76) |
| South | 0.9x | 1 | x | 3.3 | x | 46.75 | x | 0.9 | x | 0.9 | = | 112.47 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 46.75 | x | 0.9 | x | 0.9 | = | 105.65 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 46.75 | x | 0.9 | x | 0.9 | = | 71.57 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 76.57 | x | 0.9 | x | 0.9 | = | 184.2 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 76.57 | x | 0.9 | x | 0.9 | = | 173.04 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 76.57 | x | 0.9 | x | 0.9 | = | 117.22 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 97.53 | x | 0.9 | x | 0.9 | = | 234.64 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 97.53 | x | 0.9 | x | 0.9 | = | 220.42 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 97.53 | x | 0.9 | x | 0.9 | = | 149.31 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 110.23 | x | 0.9 | x | 0.9 | = | 265.19 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 110.23 | x | 0.9 | x | 0.9 | = | 249.12 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 110.23 | x | 0.9 | x | 0.9 | = | 168.76 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 114.87 | x | 0.9 | x | 0.9 | = | 276.35 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 114.87 | x | 0.9 | x | 0.9 | = | 259.6 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 114.87 | x | 0.9 | x | 0.9 | = | 175.86 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 110.55 | x | 0.9 | x | 0.9 | = | 265.94 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 110.55 | x | 0.9 | x | 0.9 | = | 249.83 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 110.55 | x | 0.9 | x | 0.9 | = | 169.24 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 108.01 | x | 0.9 | x | 0.9 | = | 259.84 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 108.01 | x | 0.9 | x | 0.9 | = | 244.1 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 108.01 | x | 0.9 | x | 0.9 | = | 165.36 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 104.89 | x | 0.9 | x | 0.9 | = | 252.34 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 104.89 | x | 0.9 | x | 0.9 | = | 237.05 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 104.89 | x | 0.9 | x | 0.9 | = | 160.58 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 101.89 | x | 0.9 | x | 0.9 | = | 245.11 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 101.89 | x | 0.9 | x | 0.9 | = | 230.25 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 101.89 | x | 0.9 | x | 0.9 | = | 155.98 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 82.59 | x | 0.9 | x | 0.9 | = | 198.68 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 82.59 | x | 0.9 | x | 0.9 | = | 186.64 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 82.59 | x | 0.9 | x | 0.9 | = | 126.43 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 55.42 | x | 0.9 | x | 0.9 | = | 133.32 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 55.42 | x | 0.9 | x | 0.9 | = | 125.24 | (78) |
| South | 0.9x | 1 | x | 2.1 | x | 55.42 | x | 0.9 | x | 0.9 | = | 84.84 | (78) |
| South | 0.9x | 1 | x | 3.3 | x | 40.4 | x | 0.9 | x | 0.9 | = | 97.19 | (78) |
| South | 0.9x | 1 | x | 3.1 | x | 40.4 | x | 0.9 | x | 0.9 | = | 91.3 | (78) |

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| South | 0.9x | 1 | x | 2.1 | x | 40.4 | x | 0.9 | x | 0.9 | = | 61.85 | (78) |
| West | 0.9x | 1 | x | 0.98 | x | 19.64 | x | 0.9 | x | 0.9 | = | 42.09 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 38.42 | x | 0.9 | x | 0.9 | = | 82.35 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 63.27 | x | 0.9 | x | 0.9 | = | 135.61 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 92.28 | x | 0.9 | x | 0.9 | = | 197.78 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 113.09 | x | 0.9 | x | 0.9 | = | 242.39 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 115.77 | x | 0.9 | x | 0.9 | = | 248.13 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 110.22 | x | 0.9 | x | 0.9 | = | 236.23 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 94.68 | x | 0.9 | x | 0.9 | = | 202.91 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 73.59 | x | 0.9 | x | 0.9 | = | 157.72 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 45.59 | x | 0.9 | x | 0.9 | = | 97.71 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 24.49 | x | 0.9 | x | 0.9 | = | 52.49 | (80) |
| West | 0.9x | 1 | x | 0.98 | x | 16.15 | x | 0.9 | x | 0.9 | = | 34.62 | (80) |
| Rooflights | 0.9x | 1 | x | 1 | x | 26 | x | 0.7 | x | 0.7 | = | 22.93 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 54 | x | 0.7 | x | 0.7 | = | 47.63 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 96 | x | 0.7 | x | 0.7 | = | 84.67 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 150 | x | 0.7 | x | 0.7 | = | 132.3 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 192 | x | 0.7 | x | 0.7 | = | 169.34 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 200 | x | 0.7 | x | 0.7 | = | 176.4 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 189 | x | 0.7 | x | 0.7 | = | 166.7 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 157 | x | 0.7 | x | 0.7 | = | 138.47 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 115 | x | 0.7 | x | 0.7 | = | 101.43 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 66 | x | 0.7 | x | 0.7 | = | 58.21 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 33 | x | 0.7 | x | 0.7 | = | 29.11 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 21 | x | 0.7 | x | 0.7 | = | 18.52 | (82) |



Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 460.68 | 809.49 | 1167.24 | 1536.16 | 1795.37 | 1813.31 | 1735.49 | 1538.68 | 1295.14 | 911.34 | 556.45 | 391.14 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1436.02 | 1777.33 | 2095.54 | 2402.92 | 2597.52 | 2559.53 | 2450.58 | 2265.78 | 2059.09 | 1737.08 | 1450.45 | 1338.33 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 1 | 1 | 0.99 | 0.95 | 0.84 | 0.66 | 0.49 | 0.55 | 0.81 | 0.97 | 1 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.85 | 20.03 | 20.3 | 20.62 | 20.87 | 20.97 | 21 | 20.99 | 20.92 | 20.58 | 20.15 | 19.82 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 20.05 | 20.06 | 20.06 | 20.07 | 20.07 | 20.08 | 20.08 | 20.08 | 20.07 | 20.07 | 20.07 | 20.06 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 1 | 1 | 0.98 | 0.93 | 0.79 | 0.57 | 0.39 | 0.44 | 0.74 | 0.96 | 1 | 1 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 18.51 | 18.78 | 19.16 | 19.63 | 19.94 | 20.06 | 20.07 | 20.07 | 20.01 | 19.58 | 18.95 | 18.47 | (90) |

fLA = Living area ÷ (4) = 0.31 (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 18.92 | 19.16 | 19.51 | 19.93 | 20.23 | 20.34 | 20.36 | 20.36 | 20.29 | 19.89 | 19.32 | 18.88 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 18.92 | 19.16 | 19.51 | 19.93 | 20.23 | 20.34 | 20.36 | 20.36 | 20.29 | 19.89 | 19.32 | 18.88 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 1 | 0.99 | 0.98 | 0.93 | 0.8 | 0.6 | 0.42 | 0.47 | 0.76 | 0.96 | 0.99 | 1 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1433.03 | 1765.59 | 2051.15 | 2230.62 | 2084.14 | 1529.63 | 1023.79 | 1072.08 | 1557.33 | 1666.89 | 1442.77 | 1336.4 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 4098.7 | 3989.52 | 3632.52 | 3050.16 | 2352.55 | 1571.01 | 1028.48 | 1081.17 | 1699.51 | 2563.31 | 3384.44 | 4082.45 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1983.26 | 1494.48 | 1176.54 | 590.07 | 199.7 | 0 | 0 | 0 | 0 | 666.93 | 1398 | 2043.06 | |

Total per year (kWh/year) = Sum(98)$_{1...5,9...12}$ = 9552.04 (98)

Space heating requirement in kWh/m²/year 35.25 (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 2571.96 | 2024.73 | 2076.17 | 0 | 0 | 0 | 0 | (100) |
| Utilisation factor for loss hm | | | | | | | | | | | | | |
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.85 | 0.92 | 0.88 | 0 | 0 | 0 | 0 | (101) |
| Useful loss, hmLm (Watts) = (100)m x (101)m | | | | | | | | | | | | | |
| (102)m= | 0 | 0 | 0 | 0 | 0 | 2176.1 | 1855.42 | 1832.83 | 0 | 0 | 0 | 0 | (102) |
| Gains (solar gains calculated for applicable weather region, see Table 10) | | | | | | | | | | | | | |
| (103)m= | 0 | 0 | 0 | 0 | 0 | 2559.54 | 2450.58 | 2265.78 | 0 | 0 | 0 | 0 | (103) |
| *Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m* set (104)m to zero if (104)m < 3 × (98)m | | | | | | | | | | | | | |
| (104)m= | 0 | 0 | 0 | 0 | 0 | 276.07 | 442.8 | 322.11 | 0 | 0 | 0 | 0 | |

Total = Sum(104)$_{6...8}$ = 1040.99 (104)

Cooled fraction — f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)$_{6...8}$* = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 69.02 | 110.7 | 80.53 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 260.25 (107)

Space cooling requirement in kWh/m²/year — (107) ÷ (4) = 0.96 (108)

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## 9b. Energy requirements – Community heating scheme

This part is used for space heating, space cooling or water heating provided by a community scheme.

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community heat pump | | 1 | (303a) |
| Fraction of total space heat from Community heat pump | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 9552.04 | |
| Space heat from Community heat pump | (98) x (304a) x (305) x (306) = | 10029.65 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 2003.92 | |
| If DHW from community scheme: | | | |
| Water heat from Community heat pump | (64) x (303a) x (305) x (306) = | 2104.12 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 121.34 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 77.11 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f): | | | |
| mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 741.87 | (332) |



## 10b. Fuel costs – Community heating scheme

| | **Fuel** kWh/year | **Fuel Price** (Table 12) | | **Fuel Cost** £/year | |
|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | 4.24 | x 0.01 = | 425.26 | (340a) |
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 89.21 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 10.17 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 97.85 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |

| | | | | | |
|---|---|---|---|---|---|
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 742.49 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | | | |
|---|---|---|---|---|---|
| Energy cost deflator (Table 12) | | | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | | | 0.99 | (357) |
| **SAP rating (section12)** | | | | 86.23 | (358) |

## 12b. CO2 Emissions – Community heating scheme

| | | Energy kWh/year | Emission factor kg CO2/kWh | | Emissions kg CO2/year | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1799.26 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 62.97 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1862.24 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1862.24 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 40.02 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 385.03 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | | 2287.29 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | | 8.44 | (384) |
| **EI rating (section 14)** | | | | | 90.3 | (385) |

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## 13b. Primary Energy – Community heating scheme

| | | Energy kWh/year | Primary factor | | P.Energy kWh/year | |
|---|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 10643.04 | (367) |
| Electrical energy for heat distribution | [(313) x | | | = | 372.51 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | | = | 11015.55 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | | 11015.55 | (373) |
| Energy associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | | 11015.55 | (376) |
| Energy associated with space cooling | (315) x | | 3.07 | = | 236.73 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | | 3.07 | = | 2277.53 | (379) |

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| | | | |
|---|---|---|---|
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | 13529.81 | (383) |

# SAP WorkSheet: New dwelling design stage

## User Details:

| | | | |
|---|---|---|---|
| **Assessor Name:** | | **Stroma Number:** | |
| **Software Name:** | Stroma FSAP 2012 | **Software Version:** | Version: 1.0.3.11 |

## Property Address: Flat 8

**Address :** 28 Redington Road, NW3 7RB

## 1. Overall dwelling dimensions:

| | Area(m²) | | | Av. Height(m) | | | Volume(m³) | |
|---|---|---|---|---|---|---|---|---|
| Ground floor | 19 | (1a) | x | 2.9 | (2a) | = | 55.1 | (3a) |
| First floor | 134 | (1b) | x | 2.9 | (2b) | = | 388.6 | (3b) |
| Total floor area TFA = (1a)+(1b)+(1c)+(1d)+(1e)+.....(1n) | 153 | (4) | | | | | | |
| Dwelling volume | | | | (3a)+(3b)+(3c)+(3d)+(3e)+.....(3n) | | = | 443.7 | (5) |

## 2. Ventilation rate:

| | main heating | | secondary heating | | other | | total | | m³ per hour | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number of chimneys | 0 | + | 0 | + | 0 | = | 0 | x 40 = | 0 | (6a) |
| Number of open flues | 0 | + | 0 | + | 0 | = | 0 | x 20 = | 0 | (6b) |
| Number of intermittent fans | | | | | | | 3 | x 10 = | 30 | (7a) |
| Number of passive vents | | | | | | | 0 | x 10 = | 0 | (7b) |
| Number of flueless gas fires | | | | | | | 0 | x 40 = | 0 | (7c) |



| | | | Air changes per hour | |
|---|---|---|---|---|
| Infiltration due to chimneys, flues and fans = (6a)+(6b)+(7a)+(7b)+(7c) = | 30 | ÷ (5) = | 0.07 | (8) |

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

| | | | |
|---|---|---|---|
| Number of storeys in the dwelling (ns) | | 0 | (9) |
| Additional infiltration | [(9)-1]x0.1 = | 0 | (10) |
| Structural infiltration: 0.25 for steel or timber frame or 0.35 for masonry construction | | 0 | (11) |

*if both types of wall are present, use the value corresponding to the greater wall area (after deducting areas of openings); if equal user 0.35*

| | | | |
|---|---|---|---|
| If suspended wooden floor, enter 0.2 (unsealed) or 0.1 (sealed), else enter 0 | | 0 | (12) |
| If no draught lobby, enter 0.05, else enter 0 | | 0 | (13) |
| Percentage of windows and doors draught stripped | | 0 | (14) |
| Window infiltration | 0.25 - [0.2 x (14) ÷ 100] = | 0 | (15) |
| Infiltration rate | (8) + (10) + (11) + (12) + (13) + (15) = | 0 | (16) |
| Air permeability value, q50, expressed in cubic metres per hour per square metre of envelope area | | 4.5 | (17) |
| If based on air permeability value, then | (18) = [(17) ÷ 20]+(8), otherwise (18) = (16) | 0.29 | (18) |

*Air permeability value applies if a pressurisation test has been done or a degree air permeability is being used*

| | | | |
|---|---|---|---|
| Number of sides sheltered | | 1 | (19) |
| Shelter factor | (20) = 1 - [0.075 x (19)] = | 0.92 | (20) |
| Infiltration rate incorporating shelter factor | (21) = (18) x (20) = | 0.27 | (21) |

Infiltration rate modified for monthly wind speed

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Monthly average wind speed from Table 7 | | | | | | | | | | | | |
| (22)m= | 5.1 | 5 | 4.9 | 4.4 | 4.3 | 3.8 | 3.8 | 3.7 | 4 | 4.3 | 4.5 | 4.7 |

# SAP WorkSheet: New dwelling design stage

Wind Factor (22a)m = (22)m ÷ 4

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (22a)m= | 1.27 | 1.25 | 1.23 | 1.1 | 1.08 | 0.95 | 0.95 | 0.92 | 1 | 1.08 | 1.12 | 1.18 |

Adjusted infiltration rate (allowing for shelter and wind speed) = (21a) x (22a)m

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.35 | 0.34 | 0.33 | 0.3 | 0.29 | 0.26 | 0.26 | 0.25 | 0.27 | 0.29 | 0.3 | 0.32 |

*Calculate effective air change rate for the applicable case*

If mechanical ventilation: 0 (23a)

If exhaust air heat pump using Appendix N, (23b) = (23a) × Fmv (equation (N5)) , otherwise (23b) = (23a) 0 (23b)

If balanced with heat recovery: efficiency in % allowing for in-use factor (from Table 4h) = 0 (23c)

a) If balanced mechanical ventilation with heat recovery (MVHR) (24a)m = (22b)m + (23b) × [1 – (23c) ÷ 100]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24a)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24a) |

b) If balanced mechanical ventilation without heat recovery (MV) (24b)m = (22b)m + (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24b)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24b) |

c) If whole house extract ventilation or positive input ventilation from outside
if (22b)m < 0.5 × (23b), then (24c) = (23b); otherwise (24c) = (22b) m + 0.5 × (23b)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24c)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (24c) |

d) If natural ventilation or whole house positive input ventilation from loft
if (22b)m = 1, then (24d)m = (22b)m otherwise (24d)m = 0.5 + [(22b)m² x 0.5]

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (24d)m= | 0.56 | 0.56 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (24d) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (25)m= | 0.56 | 0.56 | 0.55 | 0.54 | 0.54 | 0.53 | 0.53 | 0.53 | 0.54 | 0.54 | 0.55 | 0.55 | (25) |

## 3. Heat losses and heat loss parameter:

| ELEMENT | Gross area (m²) | Openings m² | Net Area A ,m² | | U-value W/m2K | | A X U (W/K) | k-value kJ/m²·K | A X k kJ/K | |
|---|---|---|---|---|---|---|---|---|---|---|
| Doors | | | 1.68 | x | 0.8 | = | 1.344 | | | (26) |
| Windows Type 1 | | | 3.43 | x1/[1/( 1.2 )+ 0.04] | | = | 3.93 | | | (27) |
| Windows Type 2 | | | 3.3 | x1/[1/( 1.2 )+ 0.04] | | = | 3.78 | | | (27) |
| Windows Type 3 | | | 1.84 | x1/[1/( 1.2 )+ 0.04] | | = | 2.11 | | | (27) |
| Windows Type 4 | | | 1.4 | x1/[1/( 1.2 )+ 0.04] | | = | 1.6 | | | (27) |
| Rooflights Type 1 | | | 1 | x1/[1/(1.3) + 0.04] | | = | 1.3 | | | (27b) |
| Rooflights Type 2 | | | 1 | x1/[1/(1.3) + 0.04] | | = | 1.3 | | | (27b) |
| Walls Type1 | 36.7 | 0 | 36.7 | x | 0.12 | = | 4.4 | | | (29) |
| Walls Type2 | 9.57 | 0 | 9.57 | x | 0.12 | = | 1.15 | | | (29) |
| Walls Type3 | 36.77 | 0 | 36.77 | x | 0.12 | = | 4.41 | | | (29) |
| Walls Type4 | 53.36 | 1.68 | 51.68 | x | 0.12 | = | 6.2 | | | (29) |
| Walls Type5 | 98.6 | 0 | 98.6 | x | 0.12 | = | 11.83 | | | (29) |
| Walls Type6 | 53.36 | 0 | 53.36 | x | 0.12 | = | 6.4 | | | (29) |
| Walls Type7 | 9.57 | 4.2 | 5.37 | x | 0.12 | = | 0.64 | | | (29) |
| Walls Type8 | 9.86 | 0 | 9.86 | x | 0.12 | = | 1.18 | | | (29) |
| Roof | 147 | 7 | 140 | x | 0.12 | = | 16.8 | | | (30) |
| Total area of elements, m² | | | 466.79 | | | | | | | (31) |

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** for windows and roof windows, use effective window U-value calculated using formula 1/[(1/U-value)+0.04] as given in paragraph 3.2*
*** include the areas on both sides of internal walls and partitions*

| | | | |
|---|---|---|---|
| Fabric heat loss, W/K = S (A x U) | (26)…(30) + (32) = | 81.57 | (33) |
| Heat capacity Cm = S(A x k ) | ((28)…(30) + (32) + (32a)…(32e) = | 0 | (34) |
| Thermal mass parameter (TMP = Cm ÷ TFA) in kJ/m²K | Indicative Value: Medium | 250 | (35) |

*For design assessments where the details of the construction are not known precisely the indicative values of TMP in Table 1f can be used instead of a detailed calculation.*

| | | | |
|---|---|---|---|
| Thermal bridges : S (L x Y) calculated using Appendix K | | 70.02 | (36) |

*if details of thermal bridging are not known (36) = 0.15 x (31)*

| | | | |
|---|---|---|---|
| Total fabric heat loss | (33) + (36) = | 151.59 | (37) |

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

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (38)m= | 81.93 | 81.59 | 81.26 | 79.7 | 79.41 | 78.05 | 78.05 | 77.8 | 78.57 | 79.41 | 80 | 80.62 | | (38) |

Heat transfer coefficient, W/K (39)m = (37) + (38)m

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (39)m= | 233.52 | 233.18 | 232.85 | 231.29 | 231 | 229.64 | 229.64 | 229.39 | 230.17 | 231 | 231.59 | 232.21 | | |
| | | | | | | | | | Average = Sum(39)$_{1…12}$ /12= | | | | 231.29 | (39) |

Heat loss parameter (HLP), W/m²K (40)m = (39)m ÷ (4)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (40)m= | 1.53 | 1.52 | 1.52 | 1.51 | 1.51 | 1.5 | 1.5 | 1.5 | 1.5 | 1.51 | 1.51 | 1.52 | | |
| | | | | | | | | | Average = Sum(40)$_{1…12}$ /12= | | | | 1.51 | (40) |

Number of days in month (Table 1a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (41)m= | 31 | 28 | 31 | 30 | 31 | 30 | 31 | 31 | 30 | 31 | 30 | 31 | (41) |



## 4. Water heating energy requirement: kWh/year:

| | | |
|---|---|---|
| Assumed occupancy, N | 2.94 | (42) |

if TFA > 13.9, N = 1 + 1.76 x [1 - exp(-0.000349 x (TFA -13.9)2)] + 0.0013 x (TFA -13.9)
if TFA £ 13.9, N = 1

| | | |
|---|---|---|
| Annual average hot water usage in litres per day Vd,average = (25 x N) + 36 | 104 | (43) |

*Reduce the annual average hot water usage by 5% if the dwelling is designed to achieve a water use target of not more that 125 litres per person per day (all water use, hot and cold)*

*Hot water usage in litres per day for each month Vd,m = factor from Table 1c x (43)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (44)m= | 114.4 | 110.24 | 106.08 | 101.92 | 97.76 | 93.6 | 93.6 | 97.76 | 101.92 | 106.08 | 110.24 | 114.4 | | |
| | | | | | | | | | Total = Sum(44)$_{1…12}$ = | | | | 1247.95 | (44) |

*Energy content of hot water used - calculated monthly = 4.190 x Vd,m x nm x DTm / 3600 kWh/month (see Tables 1b, 1c, 1d)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (45)m= | 169.65 | 148.37 | 153.11 | 133.48 | 128.08 | 110.52 | 102.42 | 117.52 | 118.93 | 138.6 | 151.29 | 164.29 | | |
| | | | | | | | | | Total = Sum(45)$_{1…12}$ = | | | | 1636.26 | (45) |

*If instantaneous water heating at point of use (no hot water storage), enter 0 in boxes (46) to (61)*

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (46)m= | 25.45 | 22.26 | 22.97 | 20.02 | 19.21 | 16.58 | 15.36 | 17.63 | 17.84 | 20.79 | 22.69 | 24.64 | (46) |

Water storage loss:

| | | |
|---|---|---|
| Storage volume (litres) including any solar or WWHRS storage within same vessel | 1 | (47) |

If community heating and no tank in dwelling, enter 110 litres in (47)
Otherwise if no stored hot water (this includes instantaneous combi boilers) enter ‘0’ in (47)
Water storage loss:

| | | |
|---|---|---|
| a) If manufacturer’s declared loss factor is known (kWh/day): | 0 | (48) |
| Temperature factor from Table 2b | 0 | (49) |

# SAP WorkSheet: New dwelling design stage

| | | | |
|---|---|---|---|
| Energy lost from water storage, kWh/year | (48) x (49) = | 1 | (50) |
| b) If manufacturer's declared cylinder loss factor is not known: | | | |
| Hot water storage loss factor from Table 2 (kWh/litre/day) | | 0.03 | (51) |
| If community heating see section 4.3 | | | |
| Volume factor from Table 2a | | 4.93 | (52) |
| Temperature factor from Table 2b | | 0.6 | (53) |
| Energy lost from water storage, kWh/year | (47) x (51) x (52) x (53) = | 0.1 | (54) |
| Enter (50) or (54) in (55) | | 0.1 | (55) |

Water storage loss calculated for each month ((56)m = (55) × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (56)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (56) |

If cylinder contains dedicated solar storage, (57)m = (56)m x [(50) – (H11)] ÷ (50), else (57)m = (56)m where (H11) is from Appendix H

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (57)m= | 3.03 | 2.74 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | 3.03 | 2.93 | 3.03 | 2.93 | 3.03 | (57) |

Primary circuit loss (annual) from Table 3 | 0 | (58)

Primary circuit loss calculated for each month (59)m = (58) ÷ 365 × (41)m

(modified by factor from Table H5 if there is solar water heating and a cylinder thermostat)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (59)m= | 23.26 | 21.01 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | 23.26 | 22.51 | 23.26 | 22.51 | 23.26 | (59) |

Combi loss calculated for each month (61)m = (60) ÷ 365 × (41)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (61)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (61) |

Total heat required for water heating calculated for each month (62)m = 0.85 × (45)m + (46)m + (57)m + (59)m + (61)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (62)m= | 195.94 | 172.12 | 179.4 | 158.93 | 154.37 | 135.97 | 128.71 | 143.82 | 144.37 | 164.89 | 176.74 | 190.58 | (62) |

Solar DHW input calculated using Appendix G or Appendix H (negative quantity) (enter '0' if no solar contribution to water heating)

(add additional lines if FGHRS and/or WWHRS applies, see Appendix G)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (63)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (63) |

Output from water heater

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (64)m= | 195.94 | 172.12 | 179.4 | 158.93 | 154.37 | 135.97 | 128.71 | 143.82 | 144.37 | 164.89 | 176.74 | 190.58 |

Output from water heater (annual)$_{1...12}$ | 1945.83 | (64)

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (65)m= | 75.02 | 66.14 | 69.52 | 62.39 | 61.2 | 54.76 | 52.66 | 57.69 | 57.55 | 64.69 | 68.31 | 73.24 | (65) |

include (57)m in calculation of (65)m only if cylinder is in the dwelling or hot water is from community heating

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

Metabolic gains (Table 5), Watts

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (66)m= | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | 176.33 | (66) |

Lighting gains (calculated in Appendix L, equation L9 or L9a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (67)m= | 72.19 | 64.12 | 52.15 | 39.48 | 29.51 | 24.91 | 26.92 | 34.99 | 46.97 | 59.64 | 69.6 | 74.2 | (67) |

Appliances gains (calculated in Appendix L, equation L13 or L13a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (68)m= | 483.23 | 488.25 | 475.61 | 448.71 | 414.75 | 382.84 | 361.52 | 356.5 | 369.14 | 396.04 | 430 | 461.91 | (68) |

Cooking gains (calculated in Appendix L, equation L15 or L15a), also see Table 5

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (69)m= | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | 55.57 | (69) |

Pumps and fans gains (Table 5a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (70)m= | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | (70) |

Losses e.g. evaporation (negative values) (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (71)m= | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | -117.55 | (71) |

# SAP WorkSheet: New dwelling design stage

Water heating gains (Table 5)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (72)m= | 100.83 | 98.43 | 93.44 | 86.66 | 82.25 | 76.05 | 70.78 | 77.54 | 79.93 | 86.95 | 94.88 | 98.44 | (72) |

**Total internal gains =** (66)m + (67)m + (68)m + (69)m + (70)m + (71)m + (72)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (73)m= | 770.61 | 765.15 | 735.55 | 689.19 | 640.87 | 598.15 | 573.57 | 583.38 | 610.39 | 656.98 | 708.83 | 748.9 | (73) |

## 6. Solar gains:

Solar gains are calculated using solar flux from Table 6a and associated equations to convert to the applicable orientation.

| Orientation: | | Access Factor Table 6d | | Area m² | | Flux Table 6a | | g_ Table 6b | | FF Table 6c | | Gains (W) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| North | 0.9x | 1 | x | 3.3 | x | 10.63 | x | 0.9 | x | 0.9 | = | 25.58 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 10.63 | x | 0.9 | x | 0.9 | = | 14.26 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 20.32 | x | 0.9 | x | 0.9 | = | 48.89 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 20.32 | x | 0.9 | x | 0.9 | = | 27.26 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 34.53 | x | 0.9 | x | 0.9 | = | 83.07 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 34.53 | x | 0.9 | x | 0.9 | = | 46.32 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 55.46 | x | 0.9 | x | 0.9 | = | 133.43 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 55.46 | x | 0.9 | x | 0.9 | = | 74.4 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 74.72 | x | 0.9 | x | 0.9 | = | 179.74 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 74.72 | x | 0.9 | x | 0.9 | = | 100.22 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 79.99 | x | 0.9 | x | 0.9 | = | 192.42 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 79.99 | x | 0.9 | x | 0.9 | = | 107.29 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 74.68 | x | 0.9 | x | 0.9 | = | 179.65 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 74.68 | x | 0.9 | x | 0.9 | = | 100.17 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 59.25 | x | 0.9 | x | 0.9 | = | 142.53 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 59.25 | x | 0.9 | x | 0.9 | = | 79.47 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 41.52 | x | 0.9 | x | 0.9 | = | 99.88 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 41.52 | x | 0.9 | x | 0.9 | = | 55.69 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 24.19 | x | 0.9 | x | 0.9 | = | 58.19 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 24.19 | x | 0.9 | x | 0.9 | = | 32.45 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 13.12 | x | 0.9 | x | 0.9 | = | 31.56 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 13.12 | x | 0.9 | x | 0.9 | = | 17.6 | (74) |
| North | 0.9x | 1 | x | 3.3 | x | 8.86 | x | 0.9 | x | 0.9 | = | 21.33 | (74) |
| North | 0.9x | 1 | x | 1.84 | x | 8.86 | x | 0.9 | x | 0.9 | = | 11.89 | (74) |
| East | 0.9x | 3 | x | 1.4 | x | 19.64 | x | 0.9 | x | 0.9 | = | 60.13 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 38.42 | x | 0.9 | x | 0.9 | = | 117.64 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 63.27 | x | 0.9 | x | 0.9 | = | 193.73 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 92.28 | x | 0.9 | x | 0.9 | = | 282.54 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 113.09 | x | 0.9 | x | 0.9 | = | 346.27 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 115.77 | x | 0.9 | x | 0.9 | = | 354.47 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 110.22 | x | 0.9 | x | 0.9 | = | 337.47 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 94.68 | x | 0.9 | x | 0.9 | = | 289.88 | (76) |

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| East | 0.9x | 3 | x | 1.4 | x | 73.59 | x | 0.9 | x | 0.9 | = | 225.32 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 45.59 | x | 0.9 | x | 0.9 | = | 139.58 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 24.49 | x | 0.9 | x | 0.9 | = | 74.98 | (76) |
| East | 0.9x | 3 | x | 1.4 | x | 16.15 | x | 0.9 | x | 0.9 | = | 49.45 | (76) |
| South | 0.9x | 1 | x | 3.43 | x | 46.75 | x | 0.9 | x | 0.9 | = | 233.8 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 76.57 | x | 0.9 | x | 0.9 | = | 382.91 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 97.53 | x | 0.9 | x | 0.9 | = | 487.76 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 110.23 | x | 0.9 | x | 0.9 | = | 551.28 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 114.87 | x | 0.9 | x | 0.9 | = | 574.46 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 110.55 | x | 0.9 | x | 0.9 | = | 552.84 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 108.01 | x | 0.9 | x | 0.9 | = | 540.16 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 104.89 | x | 0.9 | x | 0.9 | = | 524.57 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 101.89 | x | 0.9 | x | 0.9 | = | 509.52 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 82.59 | x | 0.9 | x | 0.9 | = | 413.01 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 55.42 | x | 0.9 | x | 0.9 | = | 277.14 | (78) |
| South | 0.9x | 1 | x | 3.43 | x | 40.4 | x | 0.9 | x | 0.9 | = | 202.03 | (78) |
| Rooflights | 0.9x | 1 | x | 1 | x | 26 | x | 0.7 | x | 0.7 | = | 22.93 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 26 | x | 0.7 | x | 0.7 | = | 57.33 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 54 | x | 0.7 | x | 0.7 | = | 47.63 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 54 | x | 0.7 | x | 0.7 | = | 119.07 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 96 | x | 0.7 | x | 0.7 | = | 84.67 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 96 | x | 0.7 | x | 0.7 | = | 211.68 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 150 | x | 0.7 | x | 0.7 | = | 132.3 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 150 | x | 0.7 | x | 0.7 | = | 330.75 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 192 | x | 0.7 | x | 0.7 | = | 169.34 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 192 | x | 0.7 | x | 0.7 | = | 423.36 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 200 | x | 0.7 | x | 0.7 | = | 176.4 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 200 | x | 0.7 | x | 0.7 | = | 441 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 189 | x | 0.7 | x | 0.7 | = | 166.7 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 189 | x | 0.7 | x | 0.7 | = | 416.74 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 157 | x | 0.7 | x | 0.7 | = | 138.47 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 157 | x | 0.7 | x | 0.7 | = | 346.18 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 115 | x | 0.7 | x | 0.7 | = | 101.43 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 115 | x | 0.7 | x | 0.7 | = | 253.57 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 66 | x | 0.7 | x | 0.7 | = | 58.21 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 66 | x | 0.7 | x | 0.7 | = | 145.53 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 33 | x | 0.7 | x | 0.7 | = | 29.11 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 33 | x | 0.7 | x | 0.7 | = | 72.76 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 21 | x | 0.7 | x | 0.7 | = | 18.52 | (82) |
| Rooflights | 0.9x | 1 | x | 1 | x | 21 | x | 0.7 | x | 0.7 | = | 46.3 | (82) |



Solar gains in watts, calculated for each month (83)m = Sum(74)m …(82)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (83)m= | 414.04 | 743.39 | 1107.23 | 1504.7 | 1793.4 | 1824.42 | 1740.89 | 1521.11 | 1245.41 | 846.97 | 503.14 | 349.52 | (83) |

Total gains – internal and solar (84)m = (73)m + (83)m , watts

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (84)m= | 1184.65 | 1508.53 | 1842.78 | 2193.89 | 2434.26 | 2422.57 | 2314.46 | 2104.49 | 1855.8 | 1503.95 | 1211.97 | 1098.42 | (84) |

## 7. Mean internal temperature (heating season)

Temperature during heating periods in the living area from Table 9, Th1 (°C) | 21 | (85)

Utilisation factor for gains for living area, h1,m (see Table 9a)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (86)m= | 0.99 | 0.98 | 0.96 | 0.89 | 0.75 | 0.57 | 0.43 | 0.49 | 0.74 | 0.94 | 0.99 | 1 | (86) |

Mean internal temperature in living area T1 (follow steps 3 to 7 in Table 9c)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (87)m= | 19.44 | 19.7 | 20.07 | 20.51 | 20.81 | 20.95 | 20.99 | 20.98 | 20.87 | 20.43 | 19.84 | 19.38 | (87) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (88)m= | 19.67 | 19.67 | 19.67 | 19.68 | 19.68 | 19.69 | 19.69 | 19.69 | 19.68 | 19.68 | 19.68 | 19.67 | (88) |

Utilisation factor for gains for rest of dwelling, h2,m (see Table 9a)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (89)m= | 0.99 | 0.98 | 0.94 | 0.85 | 0.68 | 0.47 | 0.3 | 0.35 | 0.64 | 0.91 | 0.98 | 0.99 | (89) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (90)m= | 17.64 | 18.01 | 18.55 | 19.15 | 19.52 | 19.66 | 19.68 | 19.68 | 19.6 | 19.07 | 18.23 | 17.57 | (90) |

fLA = Living area ÷ (4) = | 0.39 | (91)

Mean internal temperature (for the whole dwelling) = fLA × T1 + (1 – fLA) × T2

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (92)m= | 18.34 | 18.67 | 19.15 | 19.68 | 20.03 | 20.17 | 20.2 | 20.19 | 20.1 | 19.6 | 18.86 | 18.28 | (92) |

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

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (93)m= | 18.34 | 18.67 | 19.15 | 19.68 | 20.03 | 20.17 | 20.2 | 20.19 | 20.1 | 19.6 | 18.86 | 18.28 | (93) |

## 8. Space heating requirement

Set Ti to the mean internal temperature obtained at step 11 of Table 9b, so that Ti,m=(76)m and re-calculate the utilisation factor for gains using Table 9a

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utilisation factor for gains, hm: | | | | | | | | | | | | | |
| (94)m= | 0.99 | 0.97 | 0.94 | 0.85 | 0.7 | 0.51 | 0.35 | 0.41 | 0.67 | 0.91 | 0.98 | 0.99 | (94) |
| Useful gains, hmGm , W = (94)m x (84)m | | | | | | | | | | | | | |
| (95)m= | 1172.12 | 1469.84 | 1728.43 | 1865.41 | 1701.14 | 1232.3 | 817.72 | 855.8 | 1244.16 | 1365.64 | 1186.37 | 1089.59 | (95) |
| Monthly average external temperature from Table 8 | | | | | | | | | | | | | |
| (96)m= | 4.3 | 4.9 | 6.5 | 8.9 | 11.7 | 14.6 | 16.6 | 16.4 | 14.1 | 10.6 | 7.1 | 4.2 | (96) |
| Heat loss rate for mean internal temperature, Lm , W =[(39)m x [(93)m– (96)m ] | | | | | | | | | | | | | |
| (97)m= | 3279.31 | 3211.87 | 2945.76 | 2493.83 | 1923.44 | 1278.46 | 825.64 | 869.73 | 1380.15 | 2079.05 | 2722.9 | 3269.43 | (97) |
| Space heating requirement for each month, kWh/month = 0.024 x [(97)m – (95)m] x (41)m | | | | | | | | | | | | | |
| (98)m= | 1567.75 | 1170.64 | 905.69 | 452.46 | 165.39 | 0 | 0 | 0 | 0 | 530.78 | 1106.3 | 1621.8 | |

Total per year (kWh/year) = Sum(98)1...5,9...12 = | 7520.83 | (98)

Space heating requirement in kWh/m²/year | 49.16 | (99)

## 8c. Space cooling requirement

Calculated for June, July and August. See Table 10b

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Heat loss rate Lm (calculated using 25°C internal temperature and external temperature from Table 10) | | | | | | | | | | | | | |
| (100)m= | 0 | 0 | 0 | 0 | 0 | 2158.64 | 1699.35 | 1743.37 | 0 | 0 | 0 | 0 | (100) |

# SAP WorkSheet: New dwelling design stage

Utilisation factor for loss hm

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (101)m= | 0 | 0 | 0 | 0 | 0 | 0.85 | 0.91 | 0.87 | 0 | 0 | 0 | 0 | (101) |

Useful loss, hmLm (Watts) = (100)m x (101)m

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (102)m= | 0 | 0 | 0 | 0 | 0 | 1827.77 | 1537.92 | 1518.51 | 0 | 0 | 0 | 0 | (102) |

Gains (solar gains calculated for applicable weather region, see Table 10)

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (103)m= | 0 | 0 | 0 | 0 | 0 | 2422.57 | 2314.46 | 2104.49 | 0 | 0 | 0 | 0 | (103) |

*Space cooling requirement for month, whole dwelling, continuous ( kWh) = 0.024 x [(103)m – (102)m ] x (41)m*
set (104)m to zero if (104)m < 3 × (98)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (104)m= | 0 | 0 | 0 | 0 | 0 | 428.26 | 577.74 | 435.97 | 0 | 0 | 0 | 0 |

Total = Sum(104)$_{6...8}$ = 1441.97 (104)

Cooled fraction f C = cooled area ÷ (4) = 1 (105)

Intermittency factor (Table 10b)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (106)m= | 0 | 0 | 0 | 0 | 0 | 0.25 | 0.25 | 0.25 | 0 | 0 | 0 | 0 |

*Total = Sum(104)*$_{6...8}$ = 0 (106)

Space cooling requirement for month = (104)m × (105) × (106)m

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (107)m= | 0 | 0 | 0 | 0 | 0 | 107.06 | 144.44 | 108.99 | 0 | 0 | 0 | 0 |

Total = Sum(107)$_{6...8}$ = 360.49 (107)

Space cooling requirement in kWh/m²/year (107) ÷ (4) = 2.36 (108)

## 9b. Energy requirements – Community heating scheme



This part is used for space heating, space cooling or water heating provided by a community scheme.

| | | | |
|---|---|---|---|
| Fraction of space heat from secondary/supplementary heating (Table 11) '0' if none | | 0 | (301) |
| Fraction of space heat from community system 1 – (301) = | | 1 | (302) |

*The community scheme may obtain heat from several sources. The procedure allows for CHP and up to four other heat sources; the latter includes boilers, heat pumps, geothermal and waste heat from power stations. See Appendix C.*

| | | | |
|---|---|---|---|
| Fraction of heat from Community heat pump | | 1 | (303a) |
| Fraction of total space heat from Community heat pump | (302) x (303a) = | 1 | (304a) |
| Factor for control and charging method (Table 4c(3)) for community heating system | | 1 | (305) |
| Distribution loss factor (Table 12c) for community heating system | | 1.05 | (306) |
| **Space heating** | | **kWh/year** | |
| Annual space heating requirement | | 7520.83 | |
| Space heat from Community heat pump | (98) x (304a) x (305) x (306) = | 7896.87 | (307a) |
| Efficiency of secondary/supplementary heating system in % (from Table 4a or Appendix E) | | 0 | (308 |
| Space heating requirement from secondary/supplementary system | (98) x (301) x 100 ÷ (308) = | 0 | (309) |
| **Water heating** | | | |
| Annual water heating requirement | | 1945.83 | |
| If DHW from community scheme:<br>Water heat from Community heat pump | (64) x (303a) x (305) x (306) = | 2043.12 | (310a) |
| Electricity used for heat distribution | 0.01 × [(307a)…(307e) + (310a)…(310e)] = | 99.4 | (313) |
| Cooling System Energy Efficiency Ratio | | 3.38 | (314) |
| Space cooling (if there is a fixed cooling system, if not enter 0) | = (107) ÷ (314) = | 106.81 | (315) |
| Electricity for pumps and fans within dwelling (Table 4f):<br>mechanical ventilation - balanced, extract or positive input from outside | | 0 | (330a) |

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| | | | |
|---|---|---|---|
| warm air heating system fans | | 0 | (330b) |
| pump for solar water heating | | 0 | (330g) |
| Total electricity for the above, kWh/year | =(330a) + (330b) + (330g) = | 0 | (331) |
| Energy for lighting (calculated in Appendix L) | | 509.99 | (332) |

## 10b. Fuel costs – Community heating scheme

| | Fuel kWh/year | Fuel Price (Table 12) | | Fuel Cost £/year | |
|---|---|---|---|---|---|
| Space heating from CHP | (307a) x | 4.24 | x 0.01 = | 334.83 | (340a) |
| Water heating from CHP | (310a) x | 4.24 | x 0.01 = | 86.63 | (342a) |
| | | **Fuel Price** | | | |
| Space cooling (community cooling system) | (315) | 13.19 | x 0.01 = | 14.09 | (348) |
| Pumps and fans | (331) | 13.19 | x 0.01 = | 0 | (349) |
| Energy for lighting | (332) | 13.19 | x 0.01 = | 67.27 | (350) |
| Additional standing charges (Table 12) | | | | 120 | (351) |
| **Total energy cost** | = (340a)…(342e) + (345)…(354) = | | | 622.81 | (355) |

## 11b. SAP rating - Community heating scheme

| | | | |
|---|---|---|---|
| Energy cost deflator (Table 12) | | 0.42 | (356) |
| Energy cost factor (ECF) | [(355) x (356)] ÷ [(4) + 45.0] = | 1.32 | (357) |
| **SAP rating (section12)** | | 81.57 | (358) |

## 12b. $CO_2$ Emissions – Community heating scheme

| | | Energy kWh/year | Emission factor kg CO2/kWh | | Emissions kg CO2/year | |
|---|---|---|---|---|---|---|
| CO2 from other sources of space and water heating (not CHP) | | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | | 350 | (367a) |
| CO2 associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | | 0 | = | 1473.96 | (367) |
| Electrical energy for heat distribution | [(313) x | | 0.52 | = | 51.59 | (372) |
| Total CO2 associated with community systems | (363)…(366) + (368)...(372) | | | = | 1525.55 | (373) |
| CO2 associated with space heating (secondary) | (309) x | | 0 | = | 0 | (374) |
| CO2 associated with water from immersion heater or instantaneous heater | (312) x | | 0.52 | = | 0 | (375) |
| Total CO2 associated with space and water heating | (373) + (374) + (375) = | | | | 1525.55 | (376) |
| CO2 associated with space cooling | (315) x | | 0.52 | = | 55.44 | (377) |
| CO2 associated with electricity for pumps and fans within dwelling | (331)) x | | 0.52 | = | 0 | (378) |
| CO2 associated with electricity for lighting | (332))) x | | 0.52 | = | 264.69 | (379) |
| **Total CO2, kg/year** | sum of (376)…(382) = | | | | 1845.67 | (383) |
| **Dwelling CO2 Emission Rate** | (383) ÷ (4) = | | | | 12.06 | (384) |
| **EI rating (section 14)** | | | | | 87.51 | (385) |

## 13b. Primary Energy – Community heating scheme

| | Energy kWh/year | Primary factor | P.Energy kWh/year |
|---|---|---|---|

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| | | | | | |
|---|---|---|---|---|---|
| Energy from other sources of space and water heating (not CHP) | | | | | |
| Efficiency of heat source 1 (%) | If there is CHP using two fuels repeat (363) to (366) for the second fuel | | | 350 | (367a) |
| Energy associated with heat source 1 | [(307b)+(310b)] x 100 ÷ (367b) x | 0 | = | 8718.79 | (367) |
| Electrical energy for heat distribution | [(313) x | | = | 305.16 | (372) |
| Total Energy associated with community systems | (363)…(366) + (368)...(372) | | = | 9023.95 | (373) |
| *if it is negative set (373) to zero (unless specified otherwise, see C7 in Appendix C)* | | | | 9023.95 | (373) |
| Energy associated with space heating (secondary) | (309) x | 0 | = | 0 | (374) |
| Energy associated with water from immersion heater or instantaneous heater | (312) x | 3.07 | = | 0 | (375) |
| Total Energy associated with space and water heating | (373) + (374) + (375) = | | | 9023.95 | (376) |
| Energy associated with space cooling | (315) x | 3.07 | = | 327.91 | (377) |
| Energy associated with electricity for pumps and fans within dwelling | (331)) x | 3.07 | = | 0 | (378) |
| Energy associated with electricity for lighting | (332))) x | 3.07 | = | 1565.67 | (379) |
| **Total Primary Energy, kWh/year** | sum of (376)…(382) = | | | 10917.53 | (383) |